California Regional Water Quality Control Board

Santa Ana Region

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Arnold Schwarzenegger
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April 26, 2004

Notice of a Cancellation

of a
Public Workshop
for a Review of Provisions to
Incorporate Lake Elsinore/Canyon Lake Watershed Nutrient
Total Maximum Daily Loads (TMDLs)
into the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan)

The California Regional Water Quality Control Board, Santa Ana Region's public workshop to consider amendments to the Basin Plan for the incorporation of nutrient TMDLs for Lake Elsinore and Canyon Lake, is hereby cancelled. The public workshop was scheduled for April 30, 2004 at the Cucamonga County Water District; a new date and time for the public workshop will be sent to you as soon as it is scheduled. Supplemental TMDL documents and a revised proposed Basin Plan amendment will also be forwarded to you for your review prior to the public workshop.

Should you have any comments or questions regarding this matter, please contact Hope Smythe at (909)782-4493 or Xinyu (Cindy) Li at (909)782-4906.

California Regional Water Quality Control Board
Santa Ana Region

April 30, 2004

ITEM: **12**

SUBJECT: **Public Workshop: Proposed Basin Plan Amendment – Incorporation of Total Maximum Daily Loads (TMDLs) for Nutrients for Lake Elsinore and Canyon Lake**

California Regional Water Quality Control Board

Santa Ana Region

LAKE ELSINORE and CANYON LAKE NUTRIENT TOTAL MAXIMUM DAILY LOADS

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March 26, 2004
Revised 4/16/04

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Clean Water Act Section 303(d) requires that States identify waters that do not or are not expected to meet water quality standards (beneficial uses, water quality objectives) with the implementation of technology-based controls. Once a waterbody has been listed on the 303(d) list of impaired waters, states are then required to develop a Total Maximum Daily Load (TMDL) for the pollutant causing impairment. A TMDL is defined as the sum of the individual waste load allocations for point sources, load allocations for nonpoint sources and natural background. TMDLs must also address seasonal variations and include a margin of safety. In 1994, the Regional Board identified Lake Elsinore as impaired due, in part, to excessive levels of nutrients. In 1998, the Regional Board added Canyon Lake to the 303(d) list for impairment due to eutrophication and pathogens. As a result of the listing, the Regional Board initiated the development of the TMDL for nutrients for these two lakes.

This report provides the basis for the recommendation that the Regional Board consider changes to the Implementation Plan (Chapter 5 of the Water Quality Control Plan or Basin Plan) to incorporate the nutrient TMDLs for Canyon Lake and Lake Elsinore. In summary, Resolution No. RB8-2004-0037 would amend the Basin Plan to incorporate nutrient TMDLs for Lake Elsinore and Canyon Lake including the following components: problem statement; interim and final numeric targets; source analysis; wasteload allocations for point source discharges; load allocations for nonpoint source discharges; implementation plan and schedule for compliance with the TMDL; and a monitoring program for determining the effectiveness of the TMDL.

1. Introduction

The Santa Ana Regional Water Quality Control Board (Regional Board) is the California State agency responsible for water quality protection in the Santa Ana River Watershed. It is one of nine Regional Boards that function as part of the California State Water Resources Control Board (State Board) system within the California Environmental Protection Agency. The Santa Ana Regional Board implements both the federal Clean Water Act and the Porter-Cologne Water Quality Control Act, part of the California Water Code. Water quality standards and control measures for waters of the Santa Ana Region are contained in the 1995 *Water Quality Control Plan for the Santa Ana River Basin (*Basin Plan).

Under Section 303(d) of the Clean Water Act, the Regional Board is required to identify surface waters that do not or are not expected to meet water quality standards (beneficial uses, water quality objectives) with the implementation of technology-based controls. Once a waterbody has been listed on the 303(d) list of impaired waters, Regional Boards then must develop strategies called "Total Maximum Daily Loads" (TMDLs), for the pollutant causing impairment. TMDLs are composed of the sum of the Wasteload Allocations (WLA) for point source discharges, the sum of the Load Allocations (LA) for nonpoint source discharges, and a Margin of Safety (MOS). This can be expressed by the equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

The WLA and LA can be for existing sources, future sources or a combination of both. The MOS takes into account the lack of knowledge or data concerning the relationship between the WLAs and LAs and resulting water quality. The margin of safety can either be incorporated implicitly through conservative analytical approaches and assumptions used to develop the TMDL, or added explicitly as a separate component of the TMDL (EPA, 1999).

Lake Elsinore and Canyon Lake are located at the terminus of the San Jacinto River Watershed in southwestern Riverside County. The entire San Jacinto River watershed encompasses 780 square miles. Lake Elsinore is one of the few natural lakes in southern California. It was formed in a geologically active graben area and has been in existence over thousands of years. Due to the mediterranean climate and watershed hydrology, lake level fluctuations in Lake Elsinore have been extreme, with alternate periods of a dry lake bed and extreme flooding. These drought/flood cycles have a great impact on lake water quality. Fish kills and excessive algae blooms have been reported in Lake Elsinore since the early 20th century. As a result, in 1994, the Regional Board placed Lake Elsinore on the 303(d) list of impaired waters due to excessive levels of nutrients.

Canyon Lake, located approximately 2 miles upstream of Lake Elsinore, was formed by the construction of Railroad Canyon dam in 1928. Approximately 735 square miles of the 780 square mile San Jacinto River watershed drains to Canyon Lake. Only in extreme wet years does Canyon Lake overflow to Lake Elsinore; during most years, runoff from the watershed terminates at Canyon Lake without reaching Lake Elsinore, resulting in the buildup of nutrients in Canyon Lake. While Canyon Lake does not have as severe an eutrophication problem as does Lake Elsinore, there have been periods of algal blooms and occasional fish kills (anecdotal evidence, no written documentation, please see Section 3.0, Problem Statement). In 1998, the Regional Board added Canyon Lake to the 303(d) list of impaired waters due to eutrophication.

In October 2000 staff prepared the "Lake Elsinore Nutrient TMDL Problem Statement". In October 2001, staff prepared the "Canyon Lake Nutrient TMDL Problem Statement". These reports provided descriptions of the San Jacinto River Watershed, including geological and hydrological features, land uses, summaries of historical and current water quality conditions in both lakes, and existing applicable water quality standards established in the 1995 Basin Plan. The reports documented that the beneficial uses of the lakes were impaired by excessive amounts of nutrients (phosphorus and nitrogen) and provided preliminary recommendations for numeric targets to be achieved to assure that the beneficial uses of both lakes would be protected. Based on additional data and studies, the numeric targets proposed in both the Lake Elsinore and Canyon Lake Problem Statements have been revised in this report. The Lake Elsinore and Canyon Lake Problem Statements provide important background information relative to the final development of the proposed nutrient TMDLs.

Since the completion of the Lake Elsinore and Canyon Lake Problem Statements, the following studies have been conducted:

- <u>Internal Nutrient Load Quantification</u> – UC Riverside conducted studies to quantify the internal nutrient loading from Lake Elsinore and Canyon Lake sediments, as well as the response of the lakes to these internal nutrient loadings. Funding support for these studies came from the State's TMDL program.

- <u>Lake Elsinore and Canyon Lake In-lake Water Quality Monitoring</u> – Regional Board staff and watershed stakeholders have conducted in-lake monitoring since May 2000 to evaluate the current nutrient cycling processes and to determine the Lakes' response to nutrient loads from the watershed. The in-lake monitoring data were also used to characterize the spatial and temporal trends of nutrients, algal biomass, dissolved oxygen, and other water quality parameters.

- <u>Watershed Monitoring</u> – In order to determine sources of nutrients in the watershed, Regional Board staff and watershed stakeholders implemented an extensive watershed-wide monitoring program. The watershed monitoring program focused on assessing nutrient loadings from various identified land uses in the watershed. Funding support for both the Watershed Monitoring Program and the In-Lake Monitoring Program came from the Lake Elsinore and San Jacinto Watershed Project Authority (LESJWA)[1]

[1]The Lake Elsinore and San Jacinto Watershed Project Authority (LESJWA) was formed in 1999 with the passage of Proposition 13. One of the provisions in the bond was an award of $15 million for restoration of Lake Elsinore and the San Jacinto River Watershed. LESJWA, a Joint Powers Agency, was formed to

- Nutrient Watershed Modeling –Through a Clean Water Act Section 205(j) grant, LESJWA funded a watershed modeling effort to simulate nutrient loads under different hydrologic conditions and to assess the impact of various implementation plans on the water quality of Lake Elsinore and Canyon Lake.

- Lake Users Survey – LESJWA conducted a lake users survey from April through September 2002 in order to link lake users' opinions of Lake Elsinore to water quality parameters. Board staff conducted water quality monitoring on the same days the Lake Users Surveys were conducted in order to provide this linkage.

The above mentioned studies have helped to better define the nutrient dynamics in both Canyon Lake and Lake Elsinore, as well as to identify sources of nutrients to the lakes. As a result, the numeric targets proposed in the Lake Elsinore and Canyon Lake Problem Statements have been refined. The studies also allowed Board staff to establish the linkage between the proposed numeric targets and load capacity of the lakes, and to evaluate the effectiveness of possible TMDL implementation scenarios.

The purpose of this document is to provide the technical basis for the proposed TMDL. It includes the TMDL elements of problem statement, selection of water quality indicators and numeric targets, sources assessment, linkage analysis to determine load capacity, phosphorus and nitrogen TMDL, and wasteload and load allocations. Seasonal variations are considered in the source assessment and when load capacity is calculated. A margin of safety is also incorporated into the development of numeric targets and TMDL allocations. Finally, an implementation plan and schedule and a monitoring program are proposed in this document.

As in the case of many TMDLs, this TMDL is proposed to be developed, refined and implemented in a phased manner. The phased approach is appropriate when the pollutant problem is complex and there is uncertainty in the ability to adequately characterize and analyze pollutant impacts on receiving waters. For the Lake Elsinore and Canyon Lake nutrient TMDL, there are data gaps and uncertainty in understanding the nutrient and hydrologic regimes in the watershed. For instance, because TMDL development was initiated during a relatively dry period, there are no data to confirm assumptions made about nutrient loads in the watershed under extremely wet conditions, or how the lakes may respond to these nutrient loadings. Furthermore, without specific implementation and testing of implementation practices, the effectiveness of in-lake treatment and watershed management practices is uncertain. Staff recommends that this TMDL be revised periodically as new monitoring data become available, the understanding of nutrient dynamics in relationship to the lake ecosystem improves, and as the effectiveness of various management practices is evaluated.

manage and plan for Lake and watershed restoration activities using these funds. The members of LESJWA include the City of Lake Elsinore, the City of Canyon Lake, Santa Ana Watershed Project Authority (SAWPA), the County of Riverside, and Elsinore Valley MWD.

2. Watershed Overview

Lake Elsinore and Canyon Lake lie 60 miles southeast of Los Angeles and 22 miles southwest of the City of Riverside. Lake Elsinore is located within the City of Lake Elsinore in Riverside County, and is a natural low point of the San Jacinto River and its drainage basin (Figure 2-1). The total drainage area of the San Jacinto River watershed is approximately 782 square miles. Over 90 percent of the watershed (735 square miles) drains into Railroad Canyon Reservoir (Canyon Lake). Lake Elsinore is the terminus of the San Jacinto River watershed. The local tributary area to Lake Elsinore, consisting of drainage from the Santa Ana Mountains and the City of Lake Elsinore, is 47 square miles.

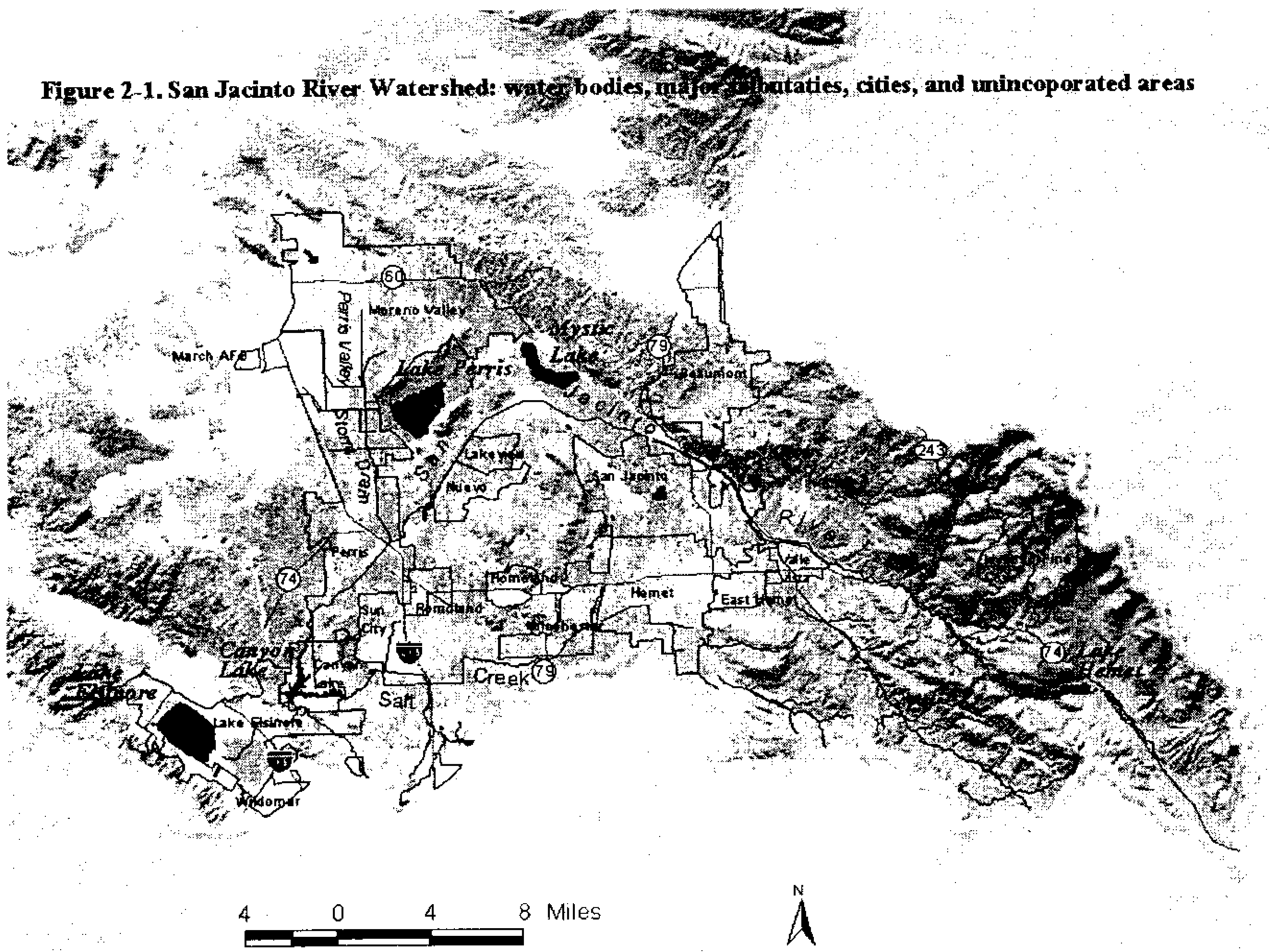
2.1 San Jacinto River Watershed – Geological and Hydrological Features

The San Jacinto River watershed is bounded by two strike-slip fault zones, the San Jacinto fault zone to the northeast and the Elsinore fault zone to the southwest. The San Jacinto Valley is among the most seismically active of the major strike-slip fault zones in southern California, and also the site of rapid subsidence (20 mm per year) due to tectonic activity and groundwater withdrawal (Morton, 1999). The rapid rate of subsidence has resulted in the formation of a strike-slip "pull-apart basin" or graben that has developed along parallel fault strands in the fault zone. The Elsinore fault zone is also a strike-slip fault zone and the subsidence along the fault formed Lake Elsinore.

As shown in Figure 2-1, flow to the San Jacinto River begins in the San Jacinto Mountains. Water flows down the San Jacinto Mountains and then northwest along the San Jacinto fault zone. Most of the flows from the mountain infiltrates into groundwater during low flow years. The extremely high subsidence rate of the San Jacinto Valley along the fault zone has resulted in a closed depression that periodically fills with water to form the ephemeral Mystic Lake. In very wet years, the surface area of Mystic Lake can expand up to 400 acres. The river makes a 90-degree turn and flows southwest at Mystic Lake. The very low river gradient westward from Mystic Lake forms a broad fluvial plain. The River then flows through the narrow Railroad Canyon, Canyon Lake, and exits the Perris Block into the lower Elsinore basin created by the Elsinore fault zone.

The major waterbodies and tributaries of the San Jacinto River watershed include Lake Hemet, Strawberry Creek, Bautista Creek, Mystic Lake, Perris Valley Storm Drain, Salt Creek, Canyon Lake (Railroad Canyon Reservoir), and Lake Elsinore.

Figure 2-1. San Jacinto River Watershed: water bodies, major tributaties, cities, and unincoporated areas



The San Jacinto River channel has been heavily altered for flood control, farming, and water supply purposes. Early in the 20th century, the U.S. Army Corps of Engineers and the Riverside County Flood Control and Water Conservation District constructed a levee along the San Jacinto River north of the City of San Jacinto to provide flood protection. Construction of the levee resulted in the accumulation of sediment in the river channel, causing the river bed to be at a higher elevation than the City, thereby exacerbating the flooding potential. Farmers in the watershed have diverted flow away from its natural path into Mystic Lake, leaving the old river bed dry. The new river channel bypasses the graben basin, thus cutting off the sediment supply that would have compensated for the rapid subsidence. Consequently, the area of the depression is expanding. Groundwater in the basin has also been withdrawn for agricultural and domestic supply purposes in the last century. As a result of all of the human engineering activities affecting the San Jacinto River, the surface flow in the River has been significantly reduced. Only in extremely wet years does water from the San Jacinto River reach Canyon Lake and Lake Elsinore.

2.2 Land Use

The majority of land in the San Jacinto basin consists of federal, state, or privately owned open space areas. According to 1993 landuse data from the Southern California Association of Governments (SCAG), land use in the watershed includes vacant land (66%), agricultural land (18%, including Confined Animal Operations such as dairies and chicken ranches, and irrigated cropland), and residential (9%) (Table 2-1). Vacant/open space is being converted to residential uses as the population in the area expands. The municipalities in the watershed include the cities of San Jacinto, Hemet, Perris, Canyon Lake, Lake Elsinore and portions of Moreno Valley, Beaumont and Murrieta (see Figure 2-1).

Table 2-1 San Jacinto Watershed 1993 Land Use[2]

Land Use Classification	Acres	Total %
Vacant	304,194	66
Agricultural	83,157	18
Residential	41,521	9
Military	5,745	1
Transportation & Utilities	4,867	1
Water & Flood Plain	3,688	1
Open Space and Preserve	2,954	1
Commercial	2,256	0.5

Data source: Montgomery Watson, 1996 (based on the SCAG 1993 data)

2.3 Characteristics of Lake Elsinore

Lake Elsinore is a relatively shallow lake with a large surface area. At the current lake outlet sill elevation of 1,255 feet, the lake has an average depth of 24.7 feet and a surface area of 3500

[2] This is the most recent published land use data available to Regional Board staff.

acres. Annual average precipitation in the Lake Elsinore watershed is approximately 11.6 inches; average annual evaporative loss is 56.2 inches (Montgomery & Watson, 1997). This excessive evaporation loss compared to natural inflow results in very low lake levels. As shown in Figure 2-2, at the extreme, Lake Elsinore was completely dry in the 1950s and 1960s. Only in extremely wet years does Lake Elsinore overflow into Temescal Creek. In the last century, Lake Elsinore only overflowed five times (1919, 1981, 1983, 1993, and 1995), causing extensive flooding to the City of Lake Elsinore. Since 1995, the lake elevation has been declining steadily (Figure 2-3).

To prevent the lake from drying out and also to mitigate the flooding potential, the U.S. Bureau of Land Management, the U.S. Army Corps of Engineers and the County of Riverside Flood Control and Water Conservation District developed the Lake Elsinore Management Project (LEMP). Three major projects were implemented through the LEMP: 1) construction of a levee to separate the main lake from the back basin to reduce the lake surface area and thereby prevent significant evaporative losses; 2) realignment of the lake inlet channel to bring natural runoff from the San Jacinto River; and, 3) lowering of the lake outlet channel to increase outflow to Temescal Creek when the lake level exceeds an elevation of 1,255 feet. The LEMP also called for the introduction of supplemental makeup water to maintain lake levels at an adopted operation range of 1,240 to 1,249 feet.

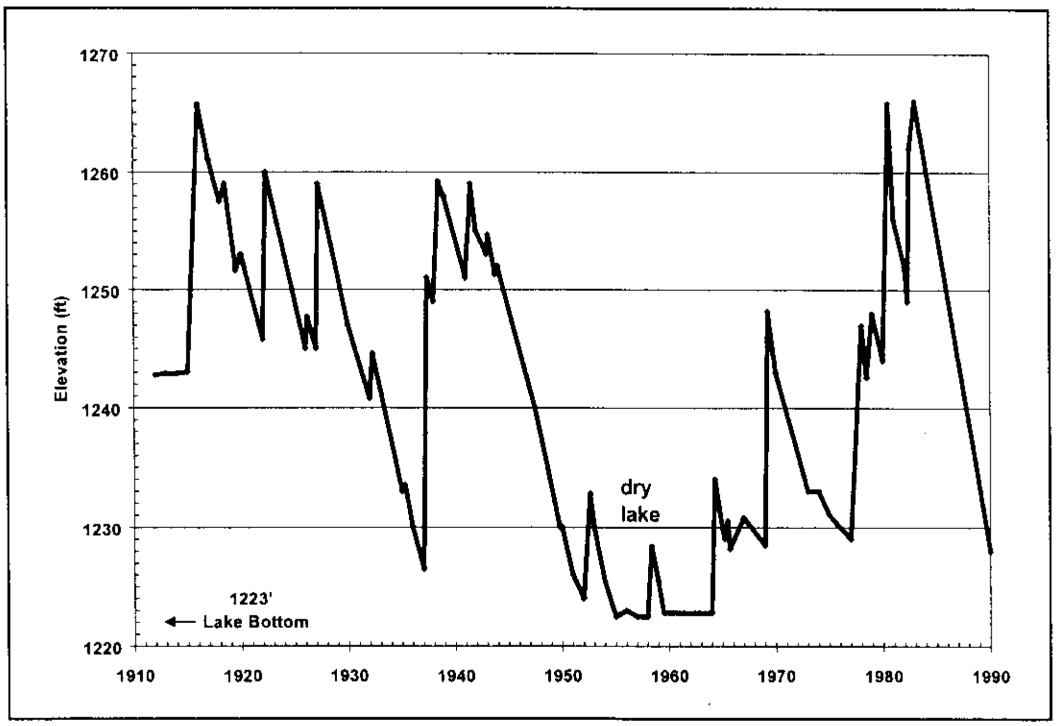


Figure 2-2. Lake Elsinore elevation from 1912 through 1990

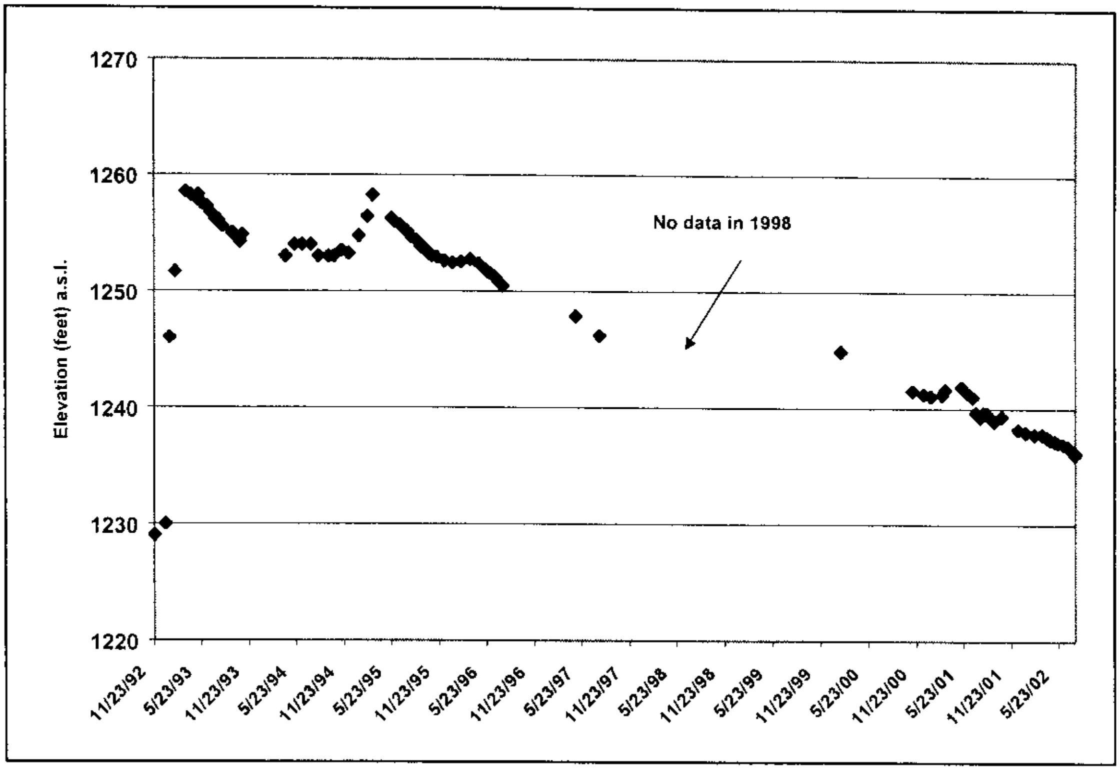


Figure 2-3. Lake Elsinore elevation from 1992 to 2002

2.4 Characteristics of Canyon Lake

Canyon Lake, also known as Railroad Canyon Reservoir, was constructed in 1928 by the Temescal Water Company. The lake was constructed to store water from the San Jacinto River for agricultural irrigation in the area. The surface area of Canyon Lake is approximately 500 acres, with a storage capacity of 11,900 acre-feet. The Railroad Canyon Reservoir dam is located approximately two miles upstream from Lake Elsinore. Approximately 735 square miles of the San Jacinto River watershed drains into Canyon Lake before reaching Lake Elsinore. During most years, drainage from the San Jacinto River watershed terminates at Canyon Lake without reaching Lake Elsinore. In the last decade, the only significant overflows from Canyon Lake to Lake Elsinore occurred in 1993, 1995, and 1998. The San Jacinto River drains to the north part of Canyon Lake. Salt Creek, the other major tributary, drains to the east part of the lake (Figure 2-4)

After construction of the Railroad Canyon Reservoir dam by the Temescal Water Company, Corona Land Company developed the land surrounding Canyon Lake. The lake and the fringe of land around it were owned by the Temescal Water Company and leased to the Canyon Lake Property Owners Association (POA) for recreational purposes. Subsequently, Elsinore Valley Municipal Water District (EVMWD) bought the Temescal Water Company, and in 1989, EVMWD entered into a contract to acquire the lake and these leases. The agreement between EVMWD and the Canyon Lake POA requires that the minimum lake elevation be kept at 1372 ft above sea level. The spillway elevation of the dam is at 1381.76 ft above sea level. In the last decade, EVMWD has supplemented the lake with water imported from the Colorado River to maintain the required water level.

In December 1990, the City of Canyon Lake was incorporated. For the most part, use of the lake is limited to City residents; public access is available north of the North Causeway (See Figure 2-4).

In addition to recreational uses, Canyon Lake is also a source of drinking water. EVMWD draws water from Canyon Lake (near the dam) and treats it at the Canyon Lake Water Treatment Plant, before delivery to the District's customers. Water from Canyon Lake comprises approximately one quarter of the total water supply of the EVMWD service area (Julius Ma, EVMWD, oral communication).

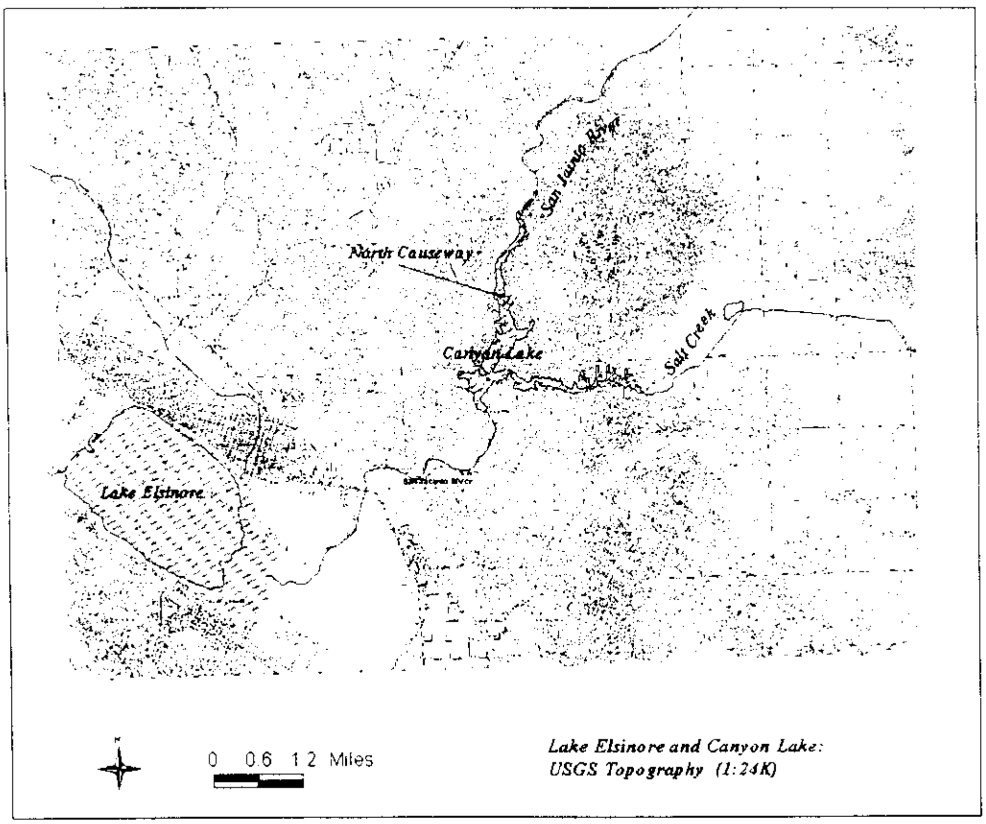


Figure 2-4. Lake Elsinore and Canyon Lake

2.5 Lake Elsinore and Canyon Lake Beneficial Uses and Water Quality Objectives

The beneficial uses of Lake Elsinore as identified in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) are as follows:

- Warm Freshwater Aquatic Habitat – **(WARM)**
- Body Contact Recreation – **(REC1)**
- Non Body Contact Recreation – **(REC2)**
- Wildlife Habitat – **(WILD)**

The Basin Plan specifies both numeric and narrative water quality objectives for Lake Elsinore that relate to nutrient impairment. These objectives are as follows:

- Total Inorganic Nitrogen **(TIN)** – 1.5 mg/L[3]

- Algae – Waste discharges shall not contribute to excessive algal growth in receiving waters.

- Un-ionized Ammonium-N (UIA)[4]:
  Acute (1-hour) Objective = 0.822 [0.87/FT/FPH/2]
  Chronic (4-day) UIA-N Objective = 0.822 [0.87/FT/FPH/RATIO]
  (Please see the 1995 Basin Plan pg. 4-5 and 4-6 for explanation of FT, FPH and RATIO)

- Dissolved Oxygen – the dissolved oxygen content of surface waters shall not be depressed below 5 mg/L for waters designated **WARM**

The beneficial uses of Canyon Lake as identified in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) are as follows:

- Municipal and Domestic Water Supply **(MUN)**
- Agriculture Water Supply **(AGR)**
- Groundwater Recharge **(GWR)**
- Body Contact Recreation – **(REC1)**
- Non Body Contact Recreation – **(REC2)**
- Warm Freshwater Aquatic Habitat – **(WARM)**
- Wildlife Habitat – **(WILD)**

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[3] TIN is the sum of nitrate, nitrite and ammonia forms of nitrogen. The TIN water quality objective was established based on the TIN historical average in the lake prior to 1975. Given the eutrophication problems in Lake Elsinore, Regional Board staff believes this value may not be protective of the WARM beneficial use and may need to be revised (See Section 4.0, Numeric Targets for detailed discussion).

[4] The UIA objectives specified in the Basin Plan have not been approved by US EPA. US EPA recommends that these objectives be reviewed and revised based on the US EPA's revised national ammonia criteria. A review of the UIA objectives was included on the Regional Board's 2002 Triennial Review list. In light of US EPA's recommendation and, as discussed in Section 4.3, staff is proposing to rely on the national UIA criteria for this TMDL.

The Basin Plan specifies both numeric and narrative water quality objectives for Canyon Lake that relate to nutrient impairment. These objectives are as follows:

- TIN -- 8 mg/L[5]

- Algae – Waste discharges shall not contribute to excessive algal growth in receiving waters.

- Un-ionized Ammonium-N (UIA):
  Acute (1-hour) Objective = 0.822 [0.87/FT/FPH/2]
  Chronic (4-day) UIA-N Objective = 0.822 [0.87/FT/FPH/RATIO]
  (Please see the 1995 Basin Plan pg. 4-5 and 4-6 for explanation of FT, FPH and RATIO)

- Dissolved Oxygen – the dissolved oxygen content of surface waters shall not be depressed below 5 mg/L for waters designated **WARM.**

The Basin Plan does not specify phosphorus water quality objectives for Lake Elsinore or Canyon Lake, yet both nitrogen and phosphorus concentrations affect algae growth in these lakes. Therefore, staff recommends that the nutrient TMDLs include both nitrogen and phosphorus components.

[5] The 8 mg/L TIN objective for Canyon Lake is intended to protect the MUN beneficial use. However, given the eutrophication problems in Canyon Lake, Regional Board staff believes that this value may not be protective of the WARM beneficial use and may need to be revised.

3. Lake Elsinore and Canyon Lake Nutrient TMDL Problem Statement

3.1 Lake Elsinore

As detailed in the October 2000 Lake Elsinore Nutrient TMDL Problem Statement, the most distinct water quality problem affecting Lake Elsinore is hypereutrophication. The hypereutrophic condition arises due to an enrichment of the Lake with nutrients (phosphorus and nitrogen), resulting in high algal productivity (mostly planktonic algae). Algae respiration and decay depletes available water column oxygen, resulting in adverse effects on aquatic biota, including fish. As shown in Table 3-1, Lake Elsinore has a long history of reported algal blooms and resulting fish kills (EDAW Inc., 1974)[6]. In all cases, the cause cited for the fish kills was the depletion of oxygen in the water column. The decay of dead algae and fish also produces offensive odors and an unsightly lakeshore, adversely affecting use of the lake for recreational purposes. In addition, the massive amount of algal cells in the water column has caused high turbidity in the lake, making the water an uninviting murky green color at times.

Comparing the fish kill record to rainfall and lake levels, it appears that fish kills coincide with either very shallow lake levels or high flows from the watershed due to heavy rainfall events. This indicates that lake levels and inputs of nutrients to the lake estimated to occur during very wet conditions are both important factors that affect the health of Lake Elsinore.

As a result of the history of fish kills and algal blooms in Lake Elsinore, in 1994, the Regional Board placed Lake Elsinore on the Clean Water Act Section 303(d) list of impaired waterbodies. For Lake Elsinore, warm freshwater aquatic habitat (WARM) and water contact and non-water contact recreation (REC1 and REC2) are the beneficial uses that are impaired by the nutrient levels.

[6] It is possible that additional fish kills occurred that are not shown on the Table 3-1. What is tabulated reflects the fish kill records that were available to Regional Board staff.

Table 3-1. Fish Kill Record in Lake Elsinore

Year	Description
1933	Fish kill and algal bloom in April reported by State Bureau of Sanitary Engineering
1940	Fish kill reported by State Bureau of Fish Conservation
1941	Fish kill reported by State Department of Fish and Game
1948	300-500 tons of carp died from Aug. 31-Sept. 2? -reported by State Department of Fish and Game
1950	"There are no fish in the Lake" -reported by Riverside County Health Department
1966	"An extensive die-off of fish" -reported by State Department of Fish and Game
1972	"During the last week of August, and continuing through September, tons of fish were buried or taken to the dump, mostly thread-fin shad" -reported by State Department of Fish and Game
1991	120 thousands tons of fish killed by algae – reported by The Press Enterprise
1992	12-15 tons fish kill on August 17 – reported by The Press Enterprise
1993	More than 100,000 tons of fish died - reported by Black & Veatch (1996)
1995	10 tons of fish killed, shad and bluegill in September – reported by The Press Enterprise
1996	small fish die-off in August – reported by The Press Enterprise
1997	7 tons of shad died of oxygen depletion in April – reported by The Press Enterprise
1998	200 tons fish kill - reported by The Press Enterprise
2002	100 tons of fish kill - reported by The Press Enterprise

Sources: EDAW Inc., 1974, Press Enterprise Reports, and LEMA, 1996

3.2 Canyon Lake

Similar to Lake Elsinore, eutrophication has caused water quality problems in Canyon Lake. Excessive input of nutrients (phosphorus and nitrogen) has resulted in high algal productivity. The decay of dead algae produces offensive odors and an unsightly lakeshore, adversely affecting use of the lake for water-contact and non-contact recreational purposes (REC1 and REC2). In addition, the high amount of algal cells causes high turbidity in the lake, also making Canyon Lake an uninviting murky green color at times. Canyon Lake experiences periods of oxygen depletion due to algae respiration and decomposition that can result in fish kills, adversely affecting the warm water aquatic habitat beneficial use (WARM)[7].

As previously mentioned, Canyon Lake serves as a domestic water supply to EVMWD customers. EVMWD extracts water from Canyon Lake and treats the water at the Canyon Lake Water Treatment Plant prior to delivery to its customers. The eutrophic conditions in Canyon Lake impact the MUN beneficial use. Low oxygen levels result in high concentrations of manganese and iron in the hypolimnion. When manganese levels in the water column exceed 0.45 mg/L, EVMWD shuts down the water treatment plant. The high algal productivity also

[7] Unlike Lake Elsinore, Board staff could find no written record of fish kills for Canyon Lake; there have been anecdotal occurrences of fish kills. The fact that dissolved oxygen levels in Canyon Lake can be as low as 0% saturation indicates the threat of nutrient input to the WARM beneficial use.

necessitates periodic shutdown of the Canyon Lake Water Treatment Plant because algal cells can clog the water treatment filters.

The Regional Board placed Canyon Lake on the 303(d) list of impaired waters in 1998 due to excessive nutrients levels. The municipal water supply (MUN), warm water aquatic habitat (WARM), and water contact and non-water contact recreation (REC1 and REC2) uses of Canyon Lake are the beneficial uses that are impaired by nutrients.

4.0 Numeric Targets

Pursuant to federal TMDL requirements, quantifiable and measurable numeric targets that will ensure compliance with water quality standards (beneficial uses and water quality objectives) must be established in the TMDL (US EPA, 1999). As discussed previously, municipal water supply (MUN), warm water aquatic habitat (WARM) and water contact and non-water contact recreation (REC1 and REC2) are the beneficial uses that are impaired by the high levels of nutrient inputs to Canyon Lake. For Lake Elsinore, warm freshwater aquatic habitat (WARM) and water contact and non-water contact recreation (REC1 and REC2) are the beneficial uses that are impaired by excessive nutrient input. The TMDL and its numeric targets must be structured to assure protection of all the beneficial uses and attainment of the nutrient- related water quality objectives specified in the Basin Plan.

To establish the numeric targets, Regional Board staff first considered use of established numeric nutrient objectives. As discussed in Section 2.5, the Basin Plan specifies numeric water quality objectives for nitrogen for both Lake Elsinore and Canyon Lake. The nitrogen objective for Lake Elsinore (TIN of 1.5 mg/L), was established in the 1975 Basin Plan based on the data then available. Since then, additional data have been collected. These data suggest that the TIN objective is not protective of the beneficial uses. For Canyon Lake, the TIN objective of 8 mg/L was established to protect use of the lake for municipal supply. Again, this objective is not protective of the REC1, REC2 and WARM beneficial uses. The Basin Plan does not specify numeric water quality objectives for phosphorus for either lake. Revised nitrogen objectives and new phosphorus objectives for the lakes need to be developed and considered. If and when such objectives are incorporated in the Basin Plan, it would be appropriate to apply them in the selection of numeric targets. Development of these objectives is identified as a part of the Implementation Plan for this TMDL (see Section 9.0, Implementation Recommendations).

Until appropriate objectives are established, alternative methods of identifying numeric targets must be used. Regional Board staff evaluated other alternatives to select both water quality indicators and target values. Using literature values is one approach. The US EPA National Eutrophication Survey of 894 US lakes and reservoirs resulted in classification of these lakes as oligotrophic, mesotrophic and eutrophic, based on water quality parameters such as total phosphorus, chlorophyll *a*, Secchi depth and hypolimnetic oxygen (US EPA, 1999). The values for either mesotrophic or eutrophic status have been used as long-term targets for other TMDLs (e.g., TMDL for Indian Creek Reservoir by the Lahontan Region, 2002). A second approach is to select a reference state of the water body when the beneficial uses were not impaired. Again, water quality parameters such as total phosphorus, chlorophyll *a*, secchi depth and hypolimnetic oxygen, as measured in this reference state condition, could serve as numeric targets. To define appropriate targets for protection of the REC1 and REC2 uses, data from a lake users survey could be used to link water quality parameters values to public perception of lake uses.

Board staff considered the literature values inappropriate for Lake Elsinore due to the fact that the lake has existed for over eight thousand years (Genda, 1993) and has a long eutrophic history (see Table 3-1 for fish kill record that dates back to 1933). Due to completely natural processes, Lake Elsinore has been at the eutrophic stage since the early 20th century, before the Clean

Water Act was enacted. Therefore, a reference state for Lake Elsinore based on historical water quality data seemed appropriate as the basis for selecting numeric targets. Using the same values for Canyon Lake provides consistency because the two lakes are nested in the same watershed within 3 miles of each other.

4.1 Lake Elsinore Nutrient Numeric Targets

Numeric targets for phosphorus are proposed for Lake Elsinore. Phosphorus is critical, because under the present conditions, phosphorus is generally the limiting nutrient for algal growth in Lake Elsinore (Anderson, 2000). In addition, the literature review indicates that reducing phosphorus loading would: (1) reduce algal productivity; (2) reduce dissolved oxygen depletion during summer stratification, and thus reduce the associated risk of fish kills; (3) increase water clarity; and, (4) protect and enhance aquatic life and recreational uses. Staff also proposes nitrogen numeric targets due to the fact that nitrogen can be a limiting nutrient under certain hydrological conditions (Santa Ana RWQCB, October 2000) and because both the acute and chronic ammonia toxicity criteria have been exceeded in the past. Therefore, control of both phosphorus and nitrogen is needed to ensure the protection of the lake regardless of the limiting nutrient.

Indicators and targets for parameters other than phosphorus and nitrogen are also proposed in order to track Lake Elsinore's recovery from an eutrophic state. These targets include chlorophyll *a* and dissolved oxygen. Chlorophyll is an important target since it is the parameter most closely tied to public perception of water quality in the lake. Moreover, as a biological parameter, chlorophyll also serves as an important means to gauge biological response to nutrient loads. Dissolved oxygen also serves as a measure of Lake Elsinore's response to nutrient loads.

Proposed numeric targets for Lake Elsinore are shown in Table 4-1. Board staff proposes interim numeric targets and final numeric targets. Based on the expected efficacy of programs currently being implemented by LESJWA to improve Lake water quality, staff believes that the interim targets can be achieved by 2009. Additional investigation of the water quality measures needed to achieve the final numeric target is likely to be necessary, at least for Lake Elsinore. Thus a schedule of compliance no later than 2019 is proposed.

While the phosphorus and nitrogen numeric targets will be translated into specific load allocations, the chlorophyll *a* and dissolved oxygen numeric targets will be used to monitor the recovery of Lake Elsinore. If the total phosphorus and nitrogen targets are met while the other targets are not, or vice versa, the numeric targets will be re-evaluated and revised accordingly.

Derivation of the Lake Elsinore proposed targets and comparison of these targets to current water quality is discussed in detail below.

Table 4-1. Proposed Numeric Targets and Indicators for Lake Elsinore Nutrient TMDL

Indicator	Target Value[c]	Reference
Total P concentration (interim)[a]	Annual average no greater than 0.1 mg/L; to be attained no later than 2009	25^{th} percentile of Lake Elsinore monitoring data (2000-2001considered as reference state of Lake Elsinore)
Total P concentration (final)[a]	Annual average no greater than 0.05 mg/L; to be attained no later than 2019	Model results discussed in Section 4.0
Total N concentration (interim)[a]	Annual average no greater than 1 mg/L; to be attained no later than 2009	A ratio of total N to total P of 10 is used to maintain the nutrient balance.
Total N concentration (final)[a]	Annual average no greater than 0.5 mg/L; to be attained no later than 2019	As above
Chlorophyll a concentration (interim)[b]	Summer average no greater than 40 µg/L; to be attained no later than 2009	25^{th} percentile of Lake Elsinore monitoring data (2000-2001considered as reference state of Lake Elsinore)
Chlorophyll a concentration (final)[b]	Summer average no greater than 25 µg/L; to be attained no later than 2019	Eutrophic condition (USEPA, 1990, 1999)
Dissolved oxygen concentration (interim)[b]	Depth average no less than 5 mg/L; to be attained no later than 2009	Water quality objective in the Basin Plan
Dissolved oxygen concentration (final)[b]	No less than 5 mg/L 1 meter above lake bottom and no less than 2 mg/L from 1 meter to lake sediment; to be attained no later than 2019	Water quality objective in the Basin Plan

a. source targets related to load allocations/waste load allocations
b. monitoring targets that will not be used for load allocations/waste load allocations
c. compliance with the targets to be achieved as soon as possible, but no later than the date specified

4.1.1 Phosphorus and Nitrogen

Numeric Targets

The proposed interim target for total phosphorus is 0.1 mg/L as the annual average concentration in the water column. This number represents the 25^{th} percentile of the total phosphorus concentration during the year 2000-2001 monitoring period. This time period is identified as the reference state since the lake did not experience severe algal blooms or fish kills, and the average lake elevation was 1240 feet above sea level, the acceptable operational level for Lake Elsinore. To maintain the balance of nutrients for beneficial algal growth, a ratio of total nitrogen to total phosphorus of 10 is used to derive the 1.0 mg/L interim target for total nitrogen (US EPA, 1990).

For the long-term total phosphorus target, staff initially considered a total phosphorus concentration of 0.02 mg/L, which is the concentration that US EPA considers as the dividing point between mesotrophic and eutrophic conditions. However, based upon further in-lake model evaluation, it appears that 0.02 mg/L would be unachievable in Lake Elsinore due to the excessive phosphorus load in the sediment and watershed inputs. Even if the internal phosphorus release rate is reduced by 70% and the external load is zero, the in-lake phosphorus concentration will never be below 0.05 mg/L (see discussion in Section 6.0 and Figure 6-2).

Therefore, Board staff proposes a long-term total phosphorus numeric target for Lake Elsinore of 0.5 mg/L. Again, using the 10:1 P to N ratio, the proposed long-term target for total nitrogen is a concentration no greater than 0.5 mg/L as an annual mean.

Comparison of Numeric Target and Existing Conditions in Lake Elsinore

Annual average total phosphorus and total nitrogen concentrations in Lake Elsinore from 1992 through 2002 are summarized in Table 4-2. Total phosphorus concentrations in Lake Elsinore have decreased drastically since the extremely wet conditions of 1993, while the total kjeldahl nitrogen[7] concentrations have not decreased as much. The decreasing trend in phosphorus concentrations suggests that the precipitation of phosphorus to the sediment has resulted in the removal of phosphorus from the water column. On the other hand, when the lake elevation decreases, as it has done from 2000 through 2002, the phosphorus sediment re-suspension rate and the internal flux of phosphorus increase, resulting in an increase of the total phosphorus concentration in the water column.

Table 4-2. Lake Elsinore total phosphorus and total kjeldahl nitrogen (TKN) concentrations (1992-2002)

Year	Annual Average Lake Elevation (feet asl)	Annual Average Total P (μg/L)	Annual Average TKN (mg/L)	Summer Average chlorophyll *a* (μg/L)	Data Source
1992*	1229	500	11.8	NA	SAWPA
1993	1254	678	3.24	126	SAWPA
1994	1253	371	NA	NA	SAWPA
1995	1255	260	2.89	99	SAWPA
1996	1252	213	3.05	88	SAWPA
1997	1247	195	3.08	NA	SAWPA
2000	1242	110	2.40	49	Regional Board
2001	1240	120	2.69	82	Regional Board
2002	1237	130	2.77	254	Regional Board

* Only one data point for the year
NA = no monitoring data available

[7] Total kjeldahl nitrogen (TKN), the sum of organic nitrogen and ammonium nitrogen, serves as a surrogate for total nitrogen in Lake Elsinore. In Lake Elsinore, the major form of nitrogen exists in the organic form; nitrate and nitrite are typically below detection limits.

4.1.2. Dissolved Oxygen

Dissolved oxygen is a proposed water quality indicator for Lake Elsinore. Oxygen depletion has been the cause of fish kills in the lake. In addition, anoxic conditions promote release of phosphorus from lake sediments. Benthic organisms may also be affected by anoxic conditions. Maintaining sufficient oxygen levels in the water column will prevent fish kills and reduce internal nutrient loading.

Numeric Target

The proposed dissolved oxygen interim target is a depth-averaged concentration of no less than 5 mg/L. This concentration assumes that the current fishery (mostly carp and shad) can survive under lower oxygen conditions as long as part of the lake is sufficiently oxygenated.

The final numeric target is equivalent to the narrative water quality objective for dissolved oxygen specified in the Basin Plan. The dissolved oxygen water quality objective is an instantaneous objective to be achieved at all times; however, the Basin Plan is not specific regarding applicability of the objective to the entire water column. For the final target, Board staff proposes that the 5 mg/L dissolved oxygen objective apply to the entire water column from 1 meter above the lake bottom. Selection of the 1 m depth is based on operational convenience because dissolved oxygen measurements are often taken at the 1 m intervals in the water column. When the lake is stocked with fish such as trout, catfish and bass, which are less tolerant of low-oxygen conditions, the final target should be applied at all depths in order to protect all fish populations. To protect benthic organisms, dissolved oxygen concentrations of at least 2 mg/L from the lake bottom to 1 meter above the lake bottom is proposed as a target (CH2M Hill Technical Memo #3, 2003). It should be acknowledged that there have been no studies to demonstrate that dissolved oxygen concentrations of 2 mg/L will be protective of the benthic organisms. The number is based on best professional judgment at the present time. When future studies are conducted to establish the link between dissolved oxygen and the health of habitat in Lake Elsinore, the numeric target for dissolved oxygen will be reviewed and revised accordingly.

Comparison of Numeric Target and Existing Conditions

Depth profile monitoring by Regional Board staff and UC Riverside since 2000 shows that thermal stratification of Lake Elsinore is limited; stratification lasts only a few hours to several days. The water surface is generally saturated or over-saturated with oxygen due to the photosynthetic production of oxygen. Oxygen concentrations near the lake sediments tended to be lower, and on several sampling dates, approached zero. On numerous other dates, however, dissolved oxygen concentrations stayed above 1 mg/L, often approaching 5 mg/L (in 2000-2001). In the summer of 2002, very low dissolved oxygen concentrations were observed near the water/sediment interface. In July and August 2002, dissolved oxygen concentrations less than 5 mg/L throughout the water column occurred, resulting in a fish kill in late August (Anderson, 2002).

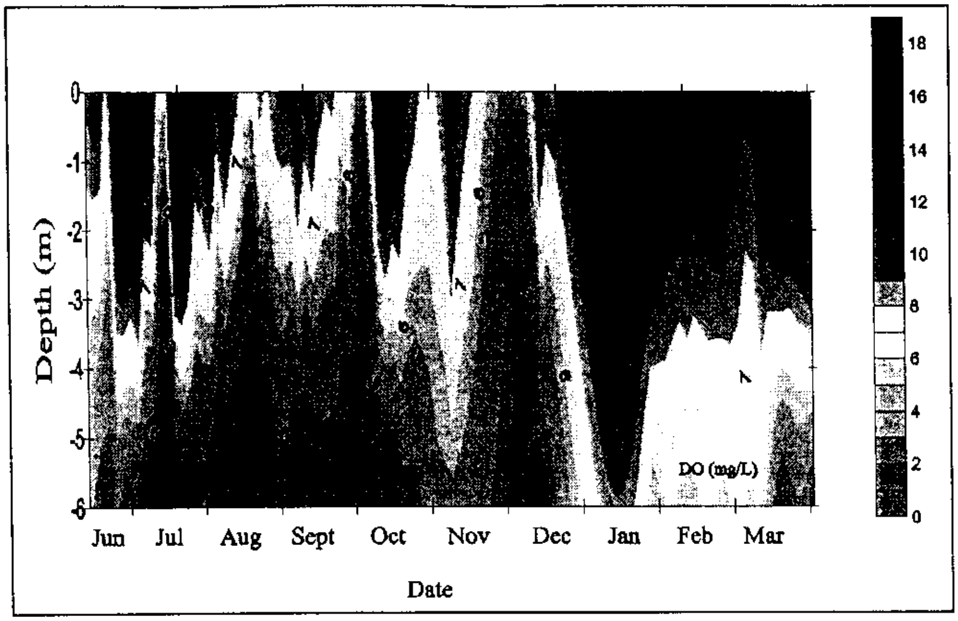


Figure 4-1. Lake Elsinore dissolved oxygen concentration from June 12, 2002 through March 26, 2003 (Anderson and Nascimento, 2003)

4.1.3. Chlorophyll *a*

Chlorophyll *a*, found in all algae and higher plants, is an indicator for algal biomass. It is also an important indicator of eutrophication status. In general, a lake with an average chlorophyll *a* concentration over 20 µg/L is considered eutrophic (US EPA, 2000).

Numeric Target

The proposed interim target for chlorophyll *a* is a summer average of 40 µg/L, which is the 25th percentile of the data collected during the 2000-2001 period, a reference state for Lake Elsinore. Coincidentally, the results of the Lake Users Survey of Lake Elsinore in April through September 2002 show that the majority of the users surveyed considered Lake Elsinore to be acceptable when chlorophyll *a* concentrations were 40 µg/L or less (Li, 2002).

For the long-term chlorophyll *a* target, the literature value of 25 µg /L is proposed00. The US EPA national eutrophic survey data suggested that a chlorophyll *a* concentration of 10-25 ug/L corresponds to eutrophic conditions.

Comparison of Numeric Targets and Existing Conditions

Summer average chlorophyll *a* concentrations measured in the past 10 years are summarized in Table 4-2. The data clearly indicate the hypereutrophic state of Lake Elsinore. High summer average chlorophyll *a* concentrations are observed after the 1993 and 1995 floods, and in the middle of the drought of 2002. Flood waters likely carried high nutrient loads from the San Jacinto River watershed to Lake Elsinore, while the drought conditions of 2001 through 2002 caused the lake elevation to drop and the water temperature and phosphorus flux rate to increase.

Both conditions resulted in severe algal blooms, as evidenced by the elevated chloroOphyll *a* concentrations.

4.2. Canyon Lake Nutrient Numeric Targets

Canyon Lake monitoring data collected by Regional Board staff and Elsinore Valley Municipal Water District (EVMWD) staff indicate that nitrogen is the primary limiting nutrient for Canyon Lake. However, both nitrogen and phosphorus can be the limiting nutrient for algal growth as the nutrient concentrations in Canyon Lake vary both spatially and temporally (Li, 2003). Therefore, both nutrients should be controlled in order to control excessive algal growth. Furthermore, since Canyon Lake overflows to Lake Elsinore in wet weather, it is necessary to also control the primary nutrient of concern in Lake Elsinore (phosphorus).

As with the Lake Elsinore proposed numeric targets, the Canyon Lake proposed numeric targets are also total phosphorus and total nitrogen. Other parameters, such as chlorophyll *a* and dissolved oxygen, are proposed as indicators for attainment of beneficial uses and to track the eutrophic status of Canyon Lake. The proposed indicators and targets are summarized in Table 4-3. Consistency with the proposed Lake Elsinore numeric targets serves as the primary criterion for selection of the numeric targets since no reference state can be identified for Canyon Lake due to lack of data.

Table 4-3. Numerical Targets and Indicators for Canyon Lake Nutrient TMDL

Indicator	Target Value[c]	Reference
Total P concentration (interim)[a]	Annual average no greater than 0.1 mg/L; to be attained by 2009	Consistent with Lake Elsinore
Total P concentration (final)[a]	Annual average no greater than 0.05 mg/L; to be attained by 2019	Consistent with Lake Elsinore
Total N concentration (interim)[a]	Annual average no greater than 1.0 mg/L; to be attained by 2009	Using a N:P ratio of 10:1
Total N concentration (final)[a]	Annual average no greater than 0.5 mg/L; to be attained by 2019	Using a N:P ratio of 10:1
Chlorophyll a concentration (interim)[b]	Annual average no greater than 40 µg/L; to be attained by 2009	Consistent with Lake Elsinore except using the annual average not the summer average (see text)
Chlorophyll a concentration (final)[b]	Annual average no greater than 25 µg/L; to be attained by 2019	Consistent with Lake Elsinore except using the annual average not the summer average (see text)
Dissolved oxygen concentration (interim)[b]	Minimum 5 mg/L above the thermocline and no less than 2 mg/L in hypolimnion; to be attained by 2009	Water quality objective in the Basin Plan
Dissolved oxygen concentration (final)[b]	Daily average at hypolimnion no less than 5 mg/L; to be attained by 2019	Water quality objective in the Basin Plan

a. source targets related to load all0ocations/waste load allocations
b. monitoring targets that will not be used for load allocations/waste load allocations
c. compliance with the targets to be achieved as soon as possible, but no later than the date specified

4.2.1 Phosphorus and Nitrogen

Numeric Targets

To be consistent with the Lake Elsinore numeric targets, an annual average total phosphorus concentration no greater than 0.1 mg/L is proposed as an interim target for Canyon Lake. To maintain the 10:1 TP to TN ratio, an annual average total nitrogen no greater than 1.0 mg/L is proposed as an interim target. The final total phosphorus and total nitrogen proposed numeric targets are 0.05 mg/L and 0.5 mg/L, respectively.

Comparison of numeric targets and existing conditions

The annual average concentrations of total phosphorus and total nitrogen for Canyon Lake are summarized in Table 4-4. Both total phosphorus and total nitrogen concentrations are higher in Canyon Lake than in Lake Elsinore. One reason is that in most years, the flow from the San Jacinto River and Salt Creek watersheds containing nutrient loads drains to and remains in Canyon Lake. Canyon Lake also stratifies during the summer, with little or no oxygen in the hypolimnion; nutrients released from lake sediments are trapped and then released when the lake turns over in the fall.

Table 4-4.Canyon Lake Water Quality Data (1998-2002)

Year	Annual Average Lake Elevation (feet asl)	Total P (µg/L)	Total N (mg/L)	Chlorophyll a (µg/L)	Data Source
1998	1379	548	1.32	NA	EVMWD
1999	1377	208	1.63	NA	EVMWD
2000	1378	408	1.58	27	Regional Board
2001	1378	341	1.53	38	Regional Board
2002	1375	356	1.59	54	Regional Board

NA = data not available, no monitoring data collected

4.2.2 Chlorophyll *a*

Numeric Target

Chlorophyll *a* is selected as a secondary indicator because excessive algal growth as measured by chlorophyll *a* results in increased turbidity levels that, in turn, cause EVMWD to shut down its water treatment plant. The reduction in algal production will improve water clarity and turbidity. An interim chlorophyll *a* target of an annual average no greater than 40 ug/L is proposed. This target is consistent with the proposed chlorophyll *a* target for Lake Elsinore. However, for Canyon Lake an annual average of chlorophyll *a* is proposed (for Lake Elsinore a summer average is proposed). This is due to the fact that Canyon Lake chlorophyll *a* concentrations exhibit greater spatial and temporal variability than Lake Elsinore. The annual average is more representative of the eutrophic status. For the final goal, a numeric target of 25 ug/L of chlorophyll *a* is proposed. Again, this target is consistent with the long-term chlorophyll *a* target for Lake Elsinore, except that it is a summer rather than an annual average target for Lake Elsinore.

Comparison of Numeric Targets and Existing Conditions

The annual average chlorophyll *a* concentrations for Canyon Lake are summarized in Table 4-4. Overall, the chlorophyll *a* concentrations in Canyon Lake are much lower than chlorophyll *a* in Lake Elsinore, even though the nutrient concentrations in Canyon Lake are higher. Canyon Lake stratifies during the summer and the nutrients released from the lake sediment are trapped in the hypolimnion, and are not available for algal uptake. When the lake turns over in the fall, chlorophyll *a* levels rise and algal blooms generally occur. Algal blooms in Canyon Lake also occur in the spring due to inputs of nutrients from the watershed during the winter rainy season.

4.2.3 Dissolved Oxygen

Numeric Target

Control of dissolved oxygen is important for Canyon Lake since the depletion of oxygen has caused occasional fish kills, high nutrient flux rates from the sediment, and elevated concentrations of iron and manganese in the water that have posed difficulties for the water treatment plant. However, there are no data to determine the level of dissolved oxygen that would be protective of all beneficial uses. Once again, the existing Bain Plan objective and consistency with Lake Elsinore are the primary criteria in selecting the target value for dissolved oxygen. For the interim target, a minimum of 5 mg/L dissolved oxygen above the thermocline and no less than 2 mg/L dissolved oxygen in the hypolimnion is proposed. For the final target, a daily average dissolved oxygen concentration no less than 5 mg/L at the hypolimnion is proposed, which is equivalent to the dissolved oxygen water quality objectives specified in the Basin Plan. When additional studies are conducted to determine the appropriate dissolved oxygen level that is protective of all beneficial uses, the numeric target will be revised accordingly.

Comparison of Numeric Targets and Existing Conditions

As depicted in Figure 4-2, dissolved oxygen concentrations in Canyon Lake, measured from July 2001 through August 2002, are generally high at the surface but low in the thermocline and hypolimnion. Dissolved oxygen concentrations were less than 1 mg/L below approximately 5 meter depth (where the thermocline is present) almost 75% of the year (Anderson *et al.*, 2002).

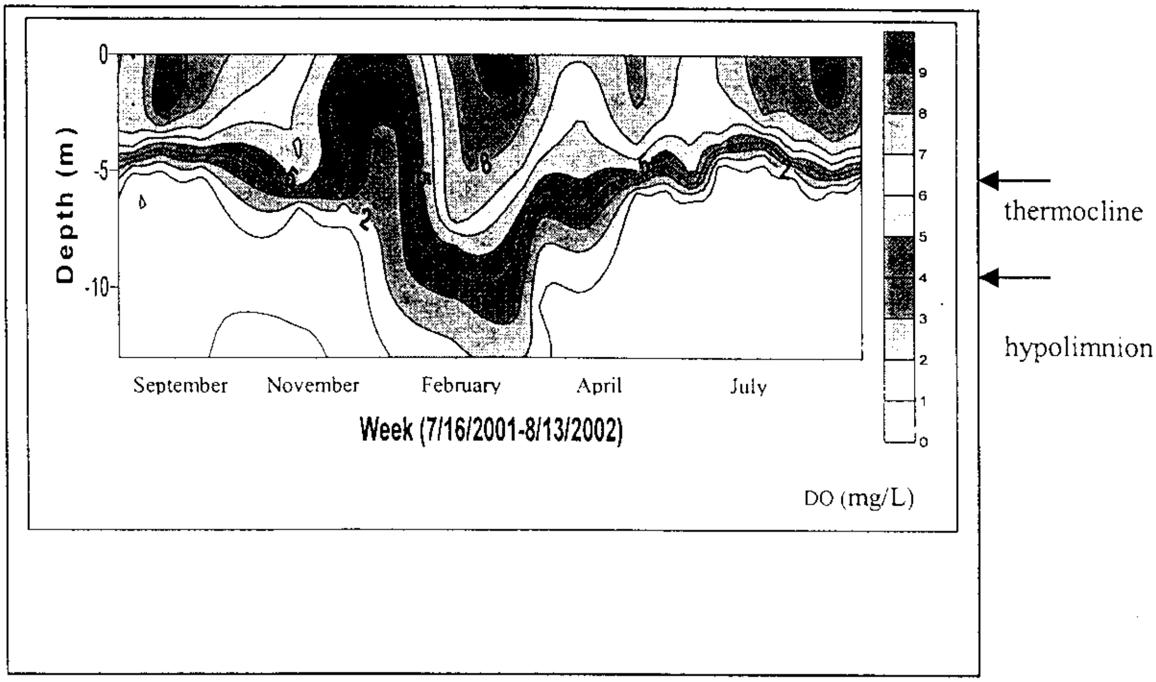


Figure 4-2. Canyon Lake dissolved oxygen profile (in mg/L) from July 2001 through August 2002 (from Anderson *et al.*, 2002).

4.3. Ammonia Toxicity Criteria

Lake Elsinore ammonia concentrations have occasionally exceeded both the acute and chronic ammonia criteria developed by the US EPA (1999) (e.g., on 1/6/01 and 12/3/02, Regional Board and UCR data). The high ammonia concentrations were observed when the dissolved oxygen was low in the water column, indicating that ammonia could be a product of mineralization of organic matter. The combination of low dissolved oxygen concentrations and high ammonia can be detrimental to aquatic life in the lake (Anderson and Veiga Nascimento, 2003: 4th Quarterly Report for Lake Elsinore Recycled Water Project). Incorporating the ammonia criteria into the Lake Elsinore nutrient TMDL will help prevent ammonia toxicity to aquatic life that has been experienced in the lake in the past.

The ammonia criteria developed by US EPA (1999) are proposed as part of the long-term nitrogen target. These criteria are expressed as equations in which toxicity varies with pH and/or water temperature. These equations also vary based on whether or not salmonid fish species are present. Since there are no native salmonid fish present in Lake Elsinore, the acute toxicity target was calculated using the equation for when salmonid fish are absent. The chronic ammonia criteria were calculated using the equations for freshwaters when early fish life stages are present. The acute and chronic ammonia criteria equations and results are shown as follows:

1. 1-hour average concentration of total ammonia nitrogen (mg/L) does not exceed, more than once every three years on the average, the CMC (acute criteria)

$$CMC = 0.411/(1+10^{7.204-pH}) + 58.4/(1+10^{pH-7.204})$$

2. The thirty-day average concentration of total ammonia nitrogen (mg/L) does not exceed, more than once every three years on the average, the CCC (chronic criteria)

$$CCC =(0.0577/(1+10^{7.688-pH}) + 2.487/(1+10^{pH-7.688})) * \min(2.85, 1.45*10^{0.028(25-T)})$$

pH-dependent values of ammonia acute toxicity criteria (total ammonia nitrogen, in mg N/L)

pH	CMC
8.0	8.41
8.5	3.20
8.6	2.65
8.7	2.20
8.8	1.84
8.9	1.56
9.0	1.32
9.5	0.70
10.0	0.50

Temperature and pH-dependent values for ammonia chronic criteria (total ammonia nitrogen, in mg N/L)

	Temperature (C)								
pH	14	16	18	20	22	24	26	28	30
8.0	2.430	2.210	1.940	1.710	1.500	1.320	1.160	1.020	0.897
8.5	1.090	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.836	0.735	0.646	0.568	0.449	0.439	0.386	0.339
8.7	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

The ammonia criteria developed by US EPA (1999) are included as part of the long-term nitrogen targets for Canyon Lake as well. The equations and the results are the same as listed for Lake Elsinore. Examination of ammonia concentrations in Canyon Lake shows that ammonia concentrations in Canyon Lake are higher than in Lake Elsinore. But because the pH values are lower in Canyon Lake than in Lake Elsinore, the acute criteria for ammonia have not been exceeded during the monitoring period (2000-2002). However, the chronic criteria have been periodically exceeded (data not shown).

The ammonia criteria are proposed as part of the long-term numeric targets, rather than the interim targets, in light of the paucity of relevant data on both ammonia concentrations and their effects on the aquatic life in Lake Elsinore and Canyon Lake. Additional investigations of ammonia-related questions are proposed as part of the implementation plan for this TMDL.

5. Nutrient Source Assessment for Lake Elsinore and Canyon Lake

In order to determine the reductions needed to achieve the proposed nutrient numeric targets and, thereby, established water quality standards, and to allocate allowable nutrient inputs among the sources, it is necessary to consider the existing and potential nutrient sources, including point, non-point and background sources. In the language of federal regulations, individual Waste Load and Load Allocations for the different sources must be determined that together will result in compliance with the TMDL. In order to do this, it was necessary to characterize all nutrient sources in the San Jacinto watershed, both external and internal.

The source assessment is a component of the TMDL that evaluates the type, magnitude, timing, and location of loading to an impaired waterbody. Several factors should be considered in conducting the source assessment. These factors include identifying the various types of sources (e.g., point, nonpoint, background, atmospheric), the relative location and magnitude of loads from the sources, the transport mechanisms of concern (e.g., runoff, infiltration), and the time scale of loading to the waterbody (i.e., duration and frequency of nutrient discharge to receiving waters) (US EPA, 1999). All of these factors were evaluated as part of the Lake Elsinore/Canyon Lake nutrient TMDL source assessment.

Lake Elsinore and Canyon Lake receive runoff from the San Jacinto River, Salt Creek and local watersheds surrounding the lakes. The USGS multi-resolution land characteristics (MRLC) 1993 data were used to assess the land use characteristics of the San Jacinto River watershed. Land use in the watershed is predominantly shrubland and forest in the headwaters area and agriculture and urban in the middle and terminal areas of the watershed. Areas surrounding both lakes are highly developed.

The unique hydrology of the San Jacinto River largely controls the magnitude and distribution of nutrient loading from external sources. All the streams in the San Jacinto River watershed are ephemeral. Thus, external sources contribute nutrients to the lakes via storm flows during the wet season (October through April). Under normal dry periods, the mainstem of the San Jacinto River is dry, contributing little or no flow to Canyon Lake, and upstream pollutants do not reach the lakes. Instead, pollutants accumulate on the land surface and are washed off during subsequent storm events. In extreme rainfall conditions, the mainstem of the San Jacinto River overflows Mystic Lake to Canyon Lake, and Canyon Lake overflows to Lake Elsinore. When these extreme rain events occur, there is frequently flooding in the basin, dairies are inundated, resulting in the transport of nutrient-rich manure and dairy wash water to the lakes. Since the lakes, particularly Lake Elsinore, are at the terminus of the watershed, the nutrient-laden flows accumulate in the lakes, causing internal nutrient loading to increase in subsequent years. In dry years, internal nutrient loading is the dominant source of nutrients to both Lake Elsinore and Canyon Lake (see the discussion in the following section).

Potential point source and nonpoint sources of nutrients to Canyon Lake and Lake Elsinore are summarized in Table 5-1.

Table 5-1. Lake Elsinore/Canyon Lake and San Jacinto River Watershed Nutrient Source Inventory

Source	Applicable Permit (Principal Permittee and Permit No.)
Point Sources	
Urban Storm-water Runoff	Waste Discharge Requirements (WDRs) for the Riverside County Flood Control and Water Conservation District and the Incorporated Cities of Riverside County within the Santa Ana Region, Areawide Urban Runoff Order No. R8-2002-0011 (NPDES No. CAS 618033)
Confined Animal Facility Operations (CAFO)	General Waste Discharge Requirements for Concentrated Animal Feeding Operations (Dairies and Related Facilities) Order No. 99-11 (NPDES No. CAG018001)
Tertiary Treated Wastewater and well water	Waste Discharge and Producer/User Reclamation Requirements for the Elsinore Valley Municipal Water District, Regional Water Reclamation Facility Riverside County Order No. R8-2002-0008-A02 (NPDES No. CA8000027)
Tertiary Treated Wastewater	Waste Discharge Requirements for Eastern Municipal Water District, Regional Water Reclamation System, Riverside County Order No. R8-2002-0008-A01 (NPDES No. CA8000188)
Stormwater Runoff associated with New Developments in the San Jacinto River Watershed	Watershed-Wide Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with New Developments in the San Jacinto Watershed Order No. 01-34 (NPDES No. CAG 618005)
Nonpoint Sources	
Agricultural Land Runoff	None
Forest/Shrub-land/Open Space	None
Atmospheric Deposition	None
Internal Nutrient Source from Lake Sediment	None
Septic Systems	None
Other Livestock	None

Canyon Lake is designated as MUN (municipal and domestic supply) and, as described above, is used by EVMWD as a source for its customers. Given these circumstances, discharges of treated sewage to Canyon Lake or to any tributary to Canyon Lake are prohibited unless approved by the California Department of Health Services (1995 Basin Plan). Eastern Municipal Water District (EMWD) and Elsinore Valley Water District (EVMWD) are the two wastewater agencies serving the San Jacinto watershed. Currently, EMWD reclaims most of its wastewater for landscape and agricultural irrigation. EVMWD discharges most of its wastewater downstream of Lake Elsinore into Temescal Creek. EMWD also has a permit to discharge excess recycled water to Temescal Creek during periods when recycled water demands are low (typically the winter months).

Since Lake Elsinore in not designated MUN and is not used as a source of drinking water supply, the Basin Plan does not prohibit wastewater discharges to the Lake. In 2002, the Regional Board revised the NPDES permits for EVMWD and EMWD to allow for the discharge of limited volumes of tertiary-treated wastewater to Lake Elsinore. These revised permits authorize the implementation of a two-year pilot project, and set to expire in December 2004. The purpose of this pilot project is to evaluate the feasibility and water quality effects of using recycled water to mitigate the evaporative water losses from Lake Elsinore. Maintenance of a stable lake level would enhance water quality and beneficial uses in the lake.

Additional point source discharges include those from urban stormwater outfalls that are currently regulated by an NPDES permit issued to the Riverside County Flood Control and Water Conservation District (RCFC&WCD) as Principal Permittee and the County of Riverside and the incorporated cities of Beaumont, Calimesa, Canyon Lake, Corona, Hemet, Lake Elsinore, Moreno Valley, Murrieta, Norco, Perris, Riverside, and San Jacinto as co-permittees. With the exception of the cities of Calimesa, Corona, and Norco, all other cities, or parts of the cities named above and part of the County of Riverside, drain into the San Jacinto River Watershed. Discharges from concentrated animal feeding operations (CAFOs) are regulated under an NPDES permit adopted by the Regional Board in 1999. Neither the stormwater permit nor the CAFO permit contains numerical effluent limits.

Nonpoint source (NPS) pollution also significantly affects the water quality of both Canyon Lake and Lake Elsinore. Unlike pollution from discrete points of discharge, NPS pollution comes from many diffuse sources that may be difficult to identify specifically. Major potential nonpoint source contributions of nutrients in the San Jacinto watershed include atmospheric deposition, agricultural runoff, and runoff from forest/shrub land/open space, septic systems and lake sediments.

The magnitude and variability of the nutrient loads from all of these nutrient sources are unknown. But limited studies have quantified the internal nutrient loads from sediments for Lake Elsinore and Canyon Lake (Anderson, 2001, Anderson and Oza, 2003). A model analysis simulated the external nutrient loading from point and nonpoint sources to Lake Elsinore and Canyon Lake (Tetra Tech., Inc. 2003). The results from these studies are summarized and discussed below.

5.1 Internal Nutrient Loading in Lake Elsinore and Canyon Lake

In-lake sediments are a major source of nutrients that affect the water quality of Lake Elsinore and Canyon Lake. Nutrient-rich sediments are transported to the lakes from the San Jacinto River watershed and accumulate in the bottom sediments. Under certain conditions (low dissolved oxygen, agitation) nutrients are released back into the water column through the processes of diffusion and re-suspension. For the following discussion, internal nutrient loading refers to nutrient release by diffusion due to the difference in the nutrient concentrations in sediment porewater and the overlying water column.

Lake Elsinore and Canyon Lake sediments were characterized for a number of properties, including particle size, carbon (C), sulfur (S) carbonate ($CaCO_3$) content and nutrient concentrations (total nitrogen (N) and total phosphorus (P)). The porewater samples were analyzed for ammonia nitrogen (NH_4-N) and soluble reactive phosphorus (SRP)[8] concentrations (Anderson, 2001, Anderson and Oza, 2003). Particle size is an important factor that determines nutrient distribution and nutrient release rates in sediment; fine-grained sediments tended to have a higher content of carbon (C), nitrogen (N), phosphorus (P), sulfur (S) and calcium carbonate ($CaCO_3$) relative to coarse-grained sediments.

Lake Elsinore Internal Nutrient Loading and Nutrient Budget

Three types of sediments were identified within Lake Elsinore. In <4 m of water, the sediments tended to be sandy, with little organic matter (Type I); at 6-7 m depth, sediments were finely textured with high organic matter and high nitrogen and phosphorus contents (Type III); and at the 4-6 m depth, the sediment was transitional Type II, with texture, carbon, nitrogen and phosphorus contents in between Type I and Type III sediments. For Lake Elsinore, the fine-grained, organic rich (Type III) sediment was estimated to occupy 1440 acres, or approximately one-half of the total sediment surface. Type I and II sediments each occupied approximately 25% of the lake bottom. The distribution of sediment in Lake Elsinore is shown in Figure 5-1. The chemical characteristics for Lake Elsinore sediments are summarized in Table 5-2.

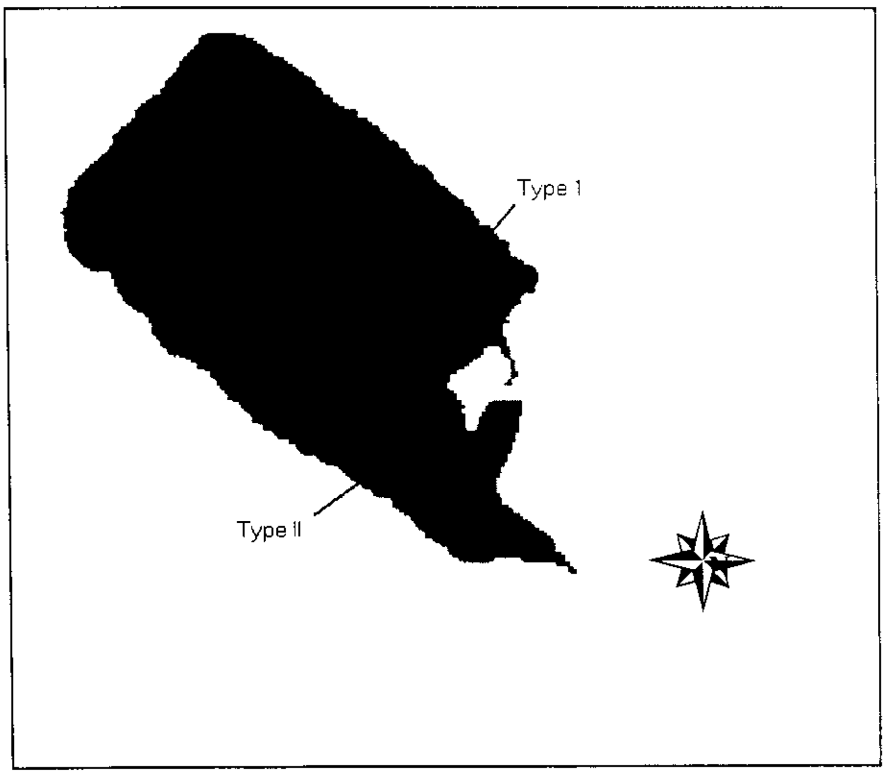


Figure 5-1. Distribution of sediment within Lake Elsinore by sediment type (modified from Anderson, 2001).

[8] SRP is equivalent to the ortho-phosphate (P).

Table 5-2. Average sediment properties by Type for Lake Elsinore (from Anderson, 2001)

AVERAGE PROPERTY	Units	Type I	Type II	Type III
AREA	acres	750	810	1440
Water Depth	m	2.8 ± 1.1	4.9 ± 0.9	6.3 ± 0.6
Sand	%	70.8 ± 31.2	29.5 ± 15.4	4.1 ± 4.0
Silt	%	19.7 ± 23.6	48.1 ± 11.9	44.8 ± 6.8
Clay	%	9.5 ± 11.7	22.3 ± 5.4	51.2 ± 6.3
Total C	%	1.07 ± 1.44	3.04 ± 0.86	5.97 ± 0.39
Organic C	%	0.79 ± 1.06	2.13 ± 0.75	4.84 ± 0.45
Inorganic C	%	0.28 ± 0.42	0.90 ± 0.20	1.14 ± 0.26
CaCO3	%	2.34 ± 3.46	7.53 ± 1.66	9.5 ± 2.2
Total N	%	0.10 ± 0.12	0.27 ± 0.07	0.53 ± 0.03
Total S	%	0.14 ± 0.30	0.53 ± 0.28	1.18 ± 0.08
Total P	mg/kg	425 ± 209	781 ± 165	916 ± 73
Inorganic P	mg/kg	340 ± 170	595 ± 128	573 ± 77
Organic P	mg/kg	84 ± 97	196 ± 104	342 ± 71
Porewater				
Soluble Reactive P	mg/L	0.6 ± 1.3	3.1 ± 0.6	4.9 ± 1.2
NH_4-N	mg/L	6.8 ± 6.9	14.5 ± 6.1	20.0 ± 3.7

In order to determine the internal loading from the lake's sediments to the overlying water column, Dr. Anderson conducted laboratory core-flux experiments. A summary of the Lake Elsinore internal nutrient loading results are tabulated in Table 5-3.

Table 5-3. Internal nutrient loading to Lake Elsinore (2000-2001) (modified from Anderson, 2001)

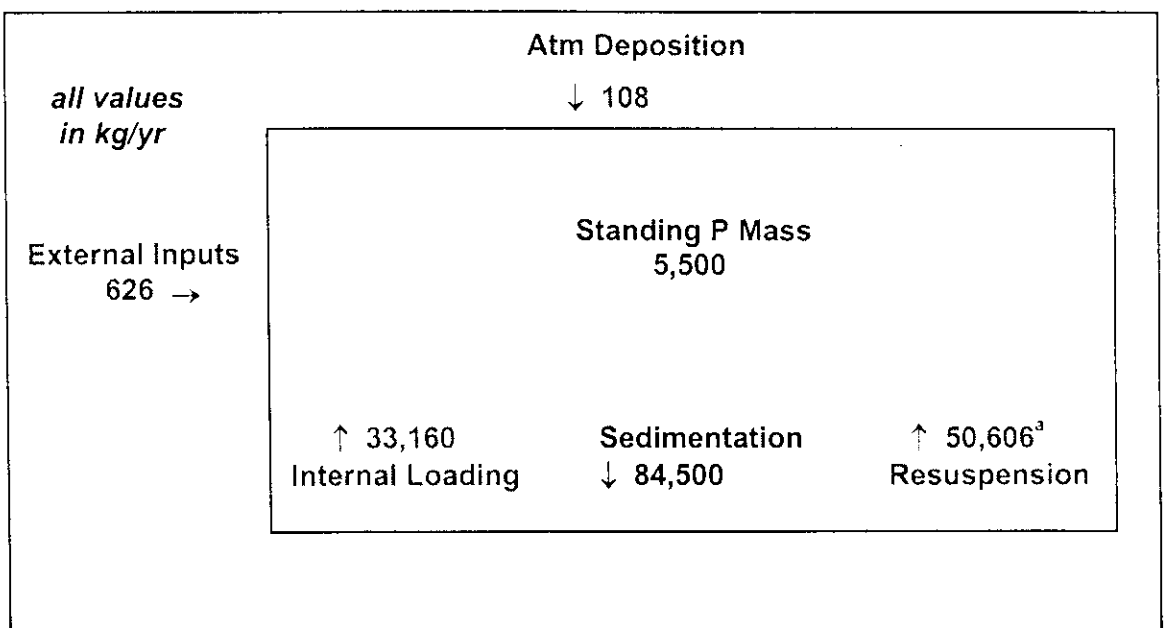
		Summer (6 mons)		Winter (6 mons)		Total
Sediment	Area	Average Flux	Loading	Average Flux	Loading	Loading
	(acres)	$mg/m^2/d$	kg	$mg/m^2/d$	kg	kg
SRP						
Type I	750	1.9	1,040	0.1	50	1,100
Type II	810	11.0	6,590	11.8	7,060	13,650
Type III	1440	10.3	10,960	7.0	7,450	18,410
Annual Total						**33,160**
NH_4-N						
Type I	750	8.0	4,430	0.1	200	4,630
Type II	810	93.1	55,740	20.8	12,450	68,190
Type III	1440	91.4	97,280	25.6	27,250	124,530
Annual Total						**197,370**

Because of the anoxic conditions at the sediment-water interface, the dominant form of nitrogen released from sediment is ammonium nitrogen (NH_4-N). For Lake Elsinore, the core-flux results demonstrate significant releases of NH_4-N and soluble reactive phosphorus (SRP) from the Type II and Type III sediment. For all three types of sediments, the release rate of NH_4-N and SRP was lower in the winter than during the summer, probably due to higher temperatures in the summer. The release rates of SRP and NH_4-N for the Type II and Type III sediments were comparable, but the rate is much lower in the sandy, less organic rich (Type I) sediment. For the period of 2000-2001, the total nutrient internal loading to Lake Elsinore was 33,160 kg SRP and 197,370 kg NH_4-N per year.

In addition to internal nutrient loading, re-suspension of sediment could also be an important source of internal nutrient load due to wave action caused by wind and bioturbation by bottom dwelling organisms such as carp. Lake Elsinore also has high deposition rates for particulate-borne nutrients, which makes measurement of the resuspension rate difficult. Alternatively, resuspension was calculated using the formula:

> Nutrient load from resuspension = Σ loads going out of water column - external input – atmospheric deposition – internal loading
>
> (for phosphorus, the term "Σ loads going out of water column", equals the sedimentation load; for nitrogen, the term "Σ loads going out of water column", equals the sum of the sedimentation and denitrification load).

The result was that 50,606 kg of phosphorus was suspended (compared to the 84, 500 kg of phosphorus that was deposited) for the 2000-2001 period (Anderson, 2001). The phosphorus budget for the 2000-2001 period in Lake Elsinore is shown in Figure 5-2.

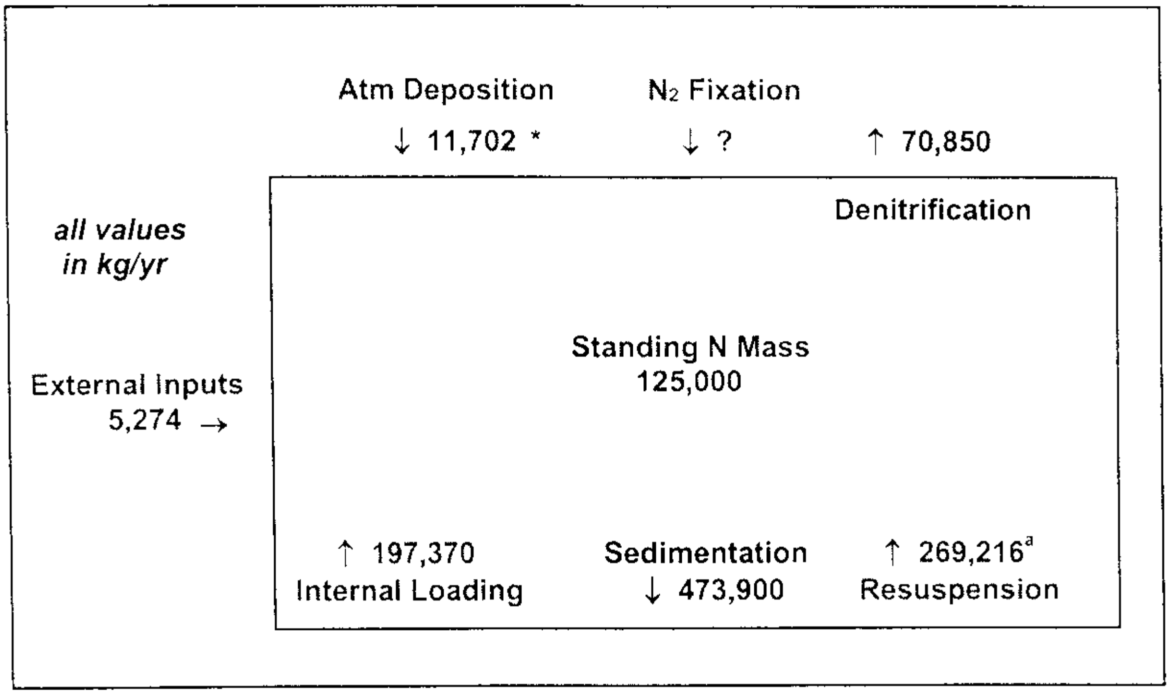


[a] Phosphorus loading from re-suspension was calculated by the formula: Resuspension = sedimentation – internal loading – external input – atmospheric deposition.

Figure 5-2. Lake Elsinore phosphorus budgets for 2000-2001 water year (Anderson, 2001).

As shown in Figure 5-2, the predominant source of phosphorus during the study period (a dry period for the lake) was the internal sources. External inputs, calculated by multiplying the flow and mean concentrations, constituted only a very small portion of the overall phosphorus loading to Lake Elsinore.

The nitrogen budget for Lake Elsinore during the 2000-2001 period was also determined, as shown in Figure 5-3. Similar to the phosphorus budget, internal loading contributed a much greater portion of the total budget (197,370 kg/yr) than the external sources (5,274 kg/yr). Re-suspension of bottom sediments added an additional 269,200 kg of nitrogen to the water column in the 2000-2001 period.



* Nitrogen deposition includes wet and dry deposition at a rate of 7.1 lbs./ac/yr. (Meixner, 2003, oral communication).
[a] Nitrogen loading from resuspension was calculated by the formula: Resuspension = sedimentation – denitrification – external input – internal loading

Figure 5-3. Lake Elsinore nitrogen budget for 2000-2001 period (modified from Anderson, 2001)

Canyon Lake Internal Nutrient Loading and Nutrient Budget

Similar to Lake Elsinore, three types of sediments were identified within Canyon Lake. Type I sediments, distributed in less than 4 m depth, were sandy with little organic matter. Type III sediments, found at 6-7 m depth, were finely textured with high organic matter and high nitrogen and phosphorus contents. Type II sediments, distributed at the 4-6 m depth, were transitional, with texture, carbon, nitrogen and phosphorus contents in between Type I and Type III sediments. For Canyon Lake, the transitional (Type II) sediments were estimated to occupy 143 acres, or 48% of the total sediment surface. Type I and III sediments occupied approximately 20% and 32% of the lake bottom, respectively. The distribution of sediment in Canyon Lake is shown in Figure 5-4. The chemical characteristics for Canyon Lake sediments are summarized in Table 5-4.

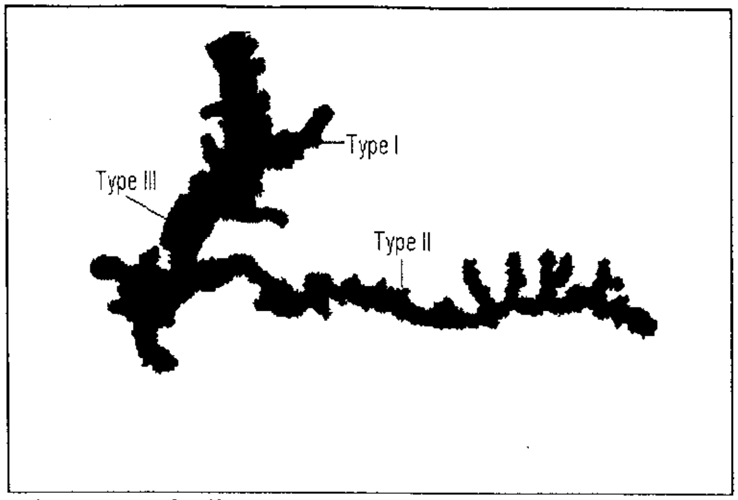


Figure 5-4. Sediment type distribution found in Canyon Lake (modified from Anderson and Oza, 2003)

Table 5-4. Average sediment properties by Type for Canyon Lake (from Anderson and Oza, 2003)

Average Property	Units	Type I	Type II	Type III
Sediment				
Area	acres	61.3	143.3	93.9
Water Depth	m	4.2 ± 2.8	3.9 ± 2.4	8.7 ± 3.1
Sand	%	45.1 ± 19.1	2.7 ± 2.9	2.8 ± 3.7
Silt	%	40.6 ± 17.1	49.1 ± 4.5	33.8 ± 4.6
Clay	%	14.3 ± 3.0	48.2 ± 5.7	64.5 ± 3.5
Total C	%	2.4 ± 1.2	4.0 ± 0.4	4.2 ± 0.5
Organic C	%	2.2 ± 0.9	2.8 ± 1.5	3.6 ± 0.4
$CaCO_3$	%	2.2 ± 2.5	4.4 ± 4.0	4.7 ± 1.6
Total N	%	0.3 ± 0.1	0.4 ± 0.0	0.5 ± 0.0
Total S	%	0.4 ± 0.2	0.7 ± 0.2	0.9 ± 0.2
Total P	mg/kg	437 ± 128	780 ± 69	937 ± 96
Inorganic P	mg/kg	382 ± 165	578 ± 44	672 ± 155
Organic P	mg/kg	55 ± 98	202 ± 60	265 ± 111
Porewater				
SRP	mg/L	2.61 ± 1.4	2.8 ± 0.9	3.0 ± 0.5
NH_4-N	mg/L	11.18 ± 4.0	14.9 ± 2.5	22.0 ± 11.0

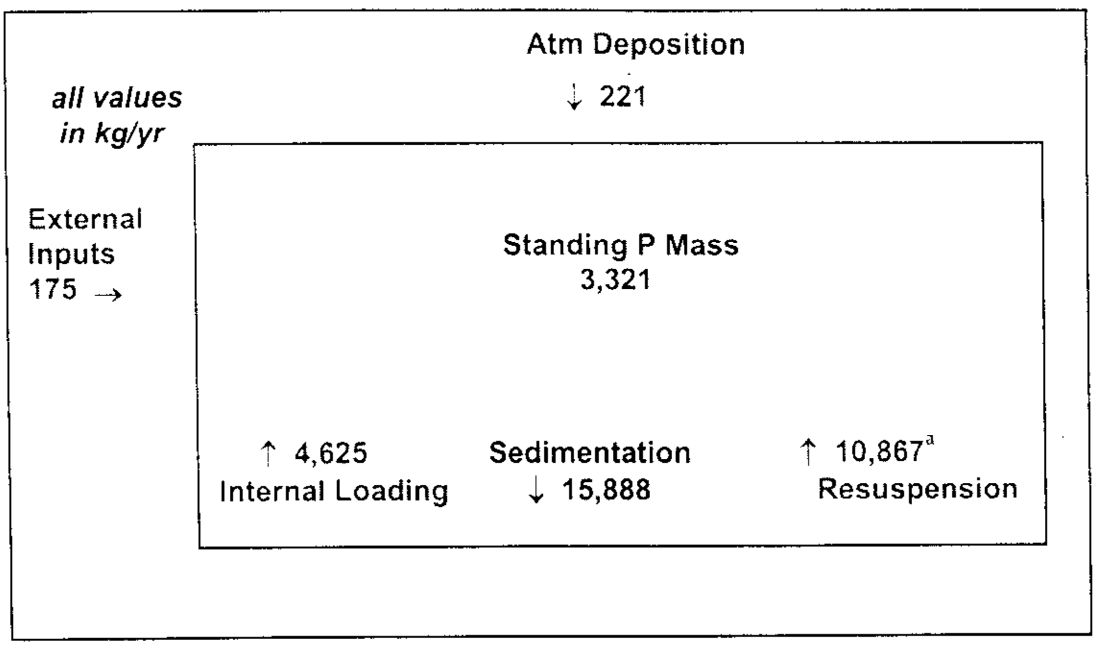
Similar to Lake Elsinore, Canyon Lake sediments released nutrients at high rates, with the SRP flux rate averaging 6.3, 15.1 and 6.5 mg/m^2/d for the Type I, II and III sediments, respectively (Table 5-5). Release of NH_4-N was found to be in the range of 22.7 to 34.8 mg/m^2/d. Internal nutrient loading rates of SRP and NH_4-N varied among sediment types. Unlike Lake Elsinore, no clear seasonal trend was observed in the nutrient release rates for Canyon Lake. Therefore, the average annual release rates for SRP and NH_4-N were used to calculate the internal loading for

Canyon Lake. For water year 2001-2002, the total nutrient internal loading to Canyon Lake was 4,625 kg of SRP and 13,549 kg of NH_4-N.

Table 5-5. Internal nutrient loading to Canyon Lake (2001-2002) (modified from Anderson and Oza, 2003)

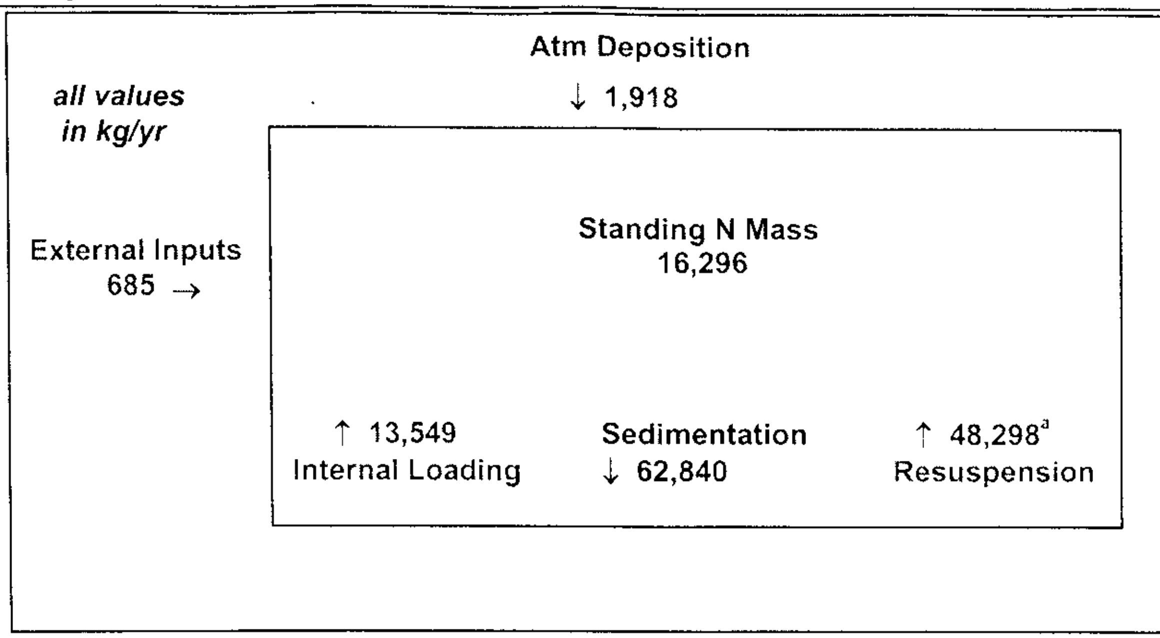
			Main Body		East Bay		Total
Sediment	Area Acres	Flux $mg/m^2/d$	Area Acres	Mass kg	Area Acres	Mass kg	kg
SRP							
Type I	61.3	6.3	47.8	446	14.4	134	580
Type II	143.3	15.1	64.8	1,444	74.5	1,664	3,108
Type III	93.9	6.5	82.6	795	14.8	142	937
Annual Total							**4,625**
NH_4-N							
Type I	61.3	22.7	47.8	1,607	14.4	483	2,090
Type II	143.3	34.8	64.8	3,328	74.5	3,836	7,164
Type III	93.9	29.8	82.6	3,643	14.8	652	4,295
Total							**13,549**

In addition to nutrient flux, sedimentation and sediment-re-suspension are important processes controlling internal nutrient cycling in Canyon Lake. Canyon Lake phosphorus and nitrogen budgets for the 2001-2002 period are shown in Figures 5-5 and 5-6.



[a] Phosphorus loading from re-suspension was calculated by the formula: Resuspension = sedimentation – internal loading – external input – atmospheric deposition.

Figure 5-5. Canyon Lake phosphorus budget for 2001 – 2002 period (modified from Anderson and Oza, 2003)



* Nitrogen deposition includes the wet and dry deposition at a rate of 7.1 lbs./ac/yr. (Meixner, 2003, oral communication). [a] Nitrogen loading from resuspension was calculated by the formula: Resuspension = sedimentation +denitrification – external input – internal loading

Figure 5-6. Canyon Lake nitrogen budget for 2001 – 2002 period (modified from Anderson and Oza, 2003)

It is important to note that the internal nutrient loading to Lake Elsinore and Canyon Lake was determined for the specified study period, i.e., water year 2000-2001 for Lake Elsinore and water year 2001-2002 for Canyon Lake. This period represents a dry hydrological time period when there was limited contribution of nutrients from the watershed (external sources) and no outflow from either lake. No data are available to determine the internal nutrient loading under other hydrologic conditions. It is possible that the internal loading would increase after heavy rainfall when the San Jacinto River carries nutrient rich water to the lakes. Further study and modeling is required to estimate the long-term internal loading to Lake Elsinore and Canyon Lake under various hydrologic regimes. However, for the development of this TMDL, the best available data are used with the recognition that additional studies are needed.

It is also important to note that the nutrient budgets developed during the sediment study periods (2000-2001 for Lake Elsinore and 2001-2002 for Canyon Lake) reflected that during a dry year, the magnitude of the internal nutrient loading is much greater than the external nutrient input. No data existed to quantify the historical external nutrient loads in the San Jacinto River watershed. Therefore, a model simulation approach was used to estimate external loads from various sources under other hydrologic conditions. The model approach is described next.

5.2 External Nutrient Source Assessment

Model analysis to determine external nutrient source loadings was conducted by Tetra Tech, Inc. with funding support from the Lake Elsinore and San Jacinto Watershed Authority through a Clean Water Act Section 205(j) grant and a Proposition 13 grant (Tetra Tech, Inc., 2003). The watershed modeling analysis utilized existing data from all sources and represents the first effort to quantify nutrient loads from various sources and various locations in the San Jacinto River watershed. The model is currently being updated as new monitoring data are collected[9].

As previously discussed, the San Jacinto River watershed is composed primarily of forest and shrubland in the headwaters, while the central watershed area consists of a mixture of urban and agricultural lands. Land-use around both Canyon Lake and Lake Elsinore is highly urbanized. Potential nutrient sources in the watershed include dairy farm runoff, runoff from cropland and pasture land, urban runoff, contributions from septic systems, and natural background (open space and forest/shrub lands). Due to the ephemeral nature of the San Jacinto River system, the location of these sources within the watershed is a major factor affecting the ultimate delivery of nutrients to Canyon Lake and Lake Elsinore. Under average rainfall conditions, urban development and agricultural land practices in the central portion of the San Jacinto River watershed below Mystic Lake (including Perris Valley and the Salt Creek sub-watershed) have the greatest impact on the water quality of Canyon Lake. However, during periods of heavy rain and/or extended periods of rainfall, the storage capacity of Mystic Lake is exceeded and surface flow from the headwaters, runoff from the cities of Hemet and San Jacinto, and agricultural runoff upstream of Mystic Lake, reach Canyon Lake. If the rainfall is significant, Canyon Lake may overflow into Lake Elsinore. Other than overflows from Canyon Lake during extreme rain events, nutrient loads to Lake Elsinore are dominated by sources downstream of Canyon Lake.

To quantify the nutrient loads to both Canyon Lake and Lake Elsinore as well as to calculate the load contributions from sources in the watershed, Tetra Tech, Inc. selected US EPA's Loading Simulation Program C++ (LSPC) model as the watershed model platform. The LSPC model has the ability to simulate all nutrient sources in the watershed, routing flow and water quality through stream networks to Canyon Lake and Lake Elsinore. To simulate Canyon Lake water quality, US EPA's Environmental Fluid Dynamics Code (EFDC) was utilized. The EFDC model simulates Canyon Lake hydrodynamics, as well as simplified nutrient processes in order to predict Canyon Lake overflow volume and the resulting contribution of nutrients in water delivered to Lake Elsinore.

To evaluate the variability of nutrient loading to Canyon Lake and Lake Elsinore due to the various hydrologic conditions that occur in the San Jacinto watershed and the existence of nested water bodies in this large drainage basin (Lake Hemet, Mystic Lake, Canyon Lake), three scenarios were simulated, *i.e.*, wet, moderate and dry (Table 5-6). Under wet conditions, the main stem of the San Jacinto River flows into and fills Mystic Lake, which then spills to Canyon Lake. Canyon Lake also spills to Lake Elsinore. Depending on the existing elevation, Lake Elsinore could fill and spill to Temescal Wash. The representative year for the wet condition during the model period is water year 1998. The moderate condition is when the main stem of the San Jacinto River doesn't flow all the way to Canyon Lake. Flows from the Salt Creek and Perris Valley Storm Drains make up the water to Canyon Lake. Canyon Lake can have moderate spills to Lake Elsinore. The representative water year during the model period is water year 1994. Under dry conditions, the flow from the San Jacinto River watershed never reaches Lake

[9] The Lake Elsinore and San Jacinto Watershed Authority has obtained additional funding support from a Proposition 13 grant to refine the model.

Elsinore. The external nutrient loads to the lake come from the runoff from the local watershed surrounding the lake, as represented by water year 2000.

Table 5-6. Three hydrologic conditions simulated by LSPC model

Scenario	Hydrologic Condition	Representative Water Year	Description
I	Wet	1998	Both Canyon Lake and Mystic Lake overflow; flow at the USGS gauging station 11070500 was 17,000 acre-feet
II	Moderate	1994	No Mystic Lake overflow; Canyon Lake overflowed, flow at the USGS gauging station 11070500 was 2,485 acre-feet
III	Dry	2000	No overflows from Mystic Lake or Canyon Lake, flow at the USGS gauging station 11070500 was 371 acre-feet

Table 5-6 also identifies the flows measured at the USGS gauging station 11070500 (located between Canyon Lake and Lake Elsinore). The annual flow at the gauging station in 1998 was approximately seven times the flow for 1994, which in turn, was nearly seven times the flow measured in 2000.

At the present, it is difficult to predict the magnitude/nature of the storms necessary to result in the three hydrological conditions, especially for scenario I. There are a variety of combinations of events that could lead to a spill from Mystic Lake, from an extremely rare event (a 1,000 year, single day event) to a series of very small storms over a period of a month or so. For example, the '69, '80 and '93 events that led to overflows of Mystic Lake were relatively insignificant in terms of rainfall intensity for short duration time periods. But the storms lasted for a long time (weeks, and a month). It should also be noted that in 1969 and 1980, there were a series of storms that inundated the Mystic Lake area prior to the storms that generated enough flow to push the water out of Mystic Lake.

While prediction is difficult, the three hydrologic scenarios are based on historical data and observations by the Riverside County Flood Control and Water Conservation District. They are real situations with significant impacts on the magnitude of nutrient loads to both Lake Elsinore and Canyon Lake (as discussed in the following section). As more data are collected and detailed hydrologic modeling analysis is conducted in the future, flow prediction may be possible, and the TMDL can be revised to reflect the new information.

5.2.1 Nutrient Loading to Canyon Lake

Annual total nitrogen and total phosphorus loads to Canyon Lake simulated by the LSPC model for 1991 to 2000 are shown in Table 5-7. The annual phosphorus and nitrogen loads to Canyon Lake varied from one year to another, depending on the amount of runoff generated by rainfall events. Over the 10-year period, phosphorus load ranged from 1,674 kg/yr to 69,158 kg/yr and averaged 17,711 kg/yr; nitrogen load ranged from 6,381 kg/yr to 226,808 kg/yr and averaged

53,192 kg. As shown in Figures 5-7 and 5-8, during the 10-year period, only three years, 1993, 1995, and 1998 (all wet years), generated nutrient loads greater than the average annual loads. In fact, the sum of nutrient loads for dry years (1991, 1992, 1994, 1996,1997, 1999, and 2000) was less than the nutrient loads for the 1993 wet year alone. As expected, very wet years contribute much greater nutrient loads from the watershed than drier years.

Table 5-7. Simulated annual nutrient loads to Canyon Lake (water years) (from Tetra Tech, 2003)

Water Year*	Precipitation At Elsinore (in)+	TP (kg)	TP (lbs.)	TN (kg)	TN (lbs.)
1991	11.90	13,422	29,591	36,688	80,883
1992	11.20	5,169	11,396	19,094	42,094
1993	21.60	69,158	152,465	226,808	500,020
1994	9.5	2,699	5,951	10,904	24,039
1995	17.30	32,619	71,912	73,950	163,029
1996	6.70	2,519	5,554	7,617	16,793
1997	7.2	4,799	10,580	8,480	18,696
1998	22.30	43,031	94,865	130,509	287,720
1999	3.80	2,020	4,454	6,381	14,067
2000	6.20	1,674	3,690	11,485	25,319
average	**11.77**	**17,711**	**39,046**	**53,192**	**117,266**
max	22.3	69,158	152,465	226,808	500,020
min	3.8	1,674	3,690	6,381	14,067
standard deviation	6.54	23,123	50,977	72,863	160,634
median	**10.35**	**4,984**	**10,988**	**15,289**	**33,707**

*A water year runs from October 1 through September 30 the next year.
+ Annual rainfall data are from July 1 through June 30 the next year (Data source: Riverside County Flood Control and Water Conservation District).

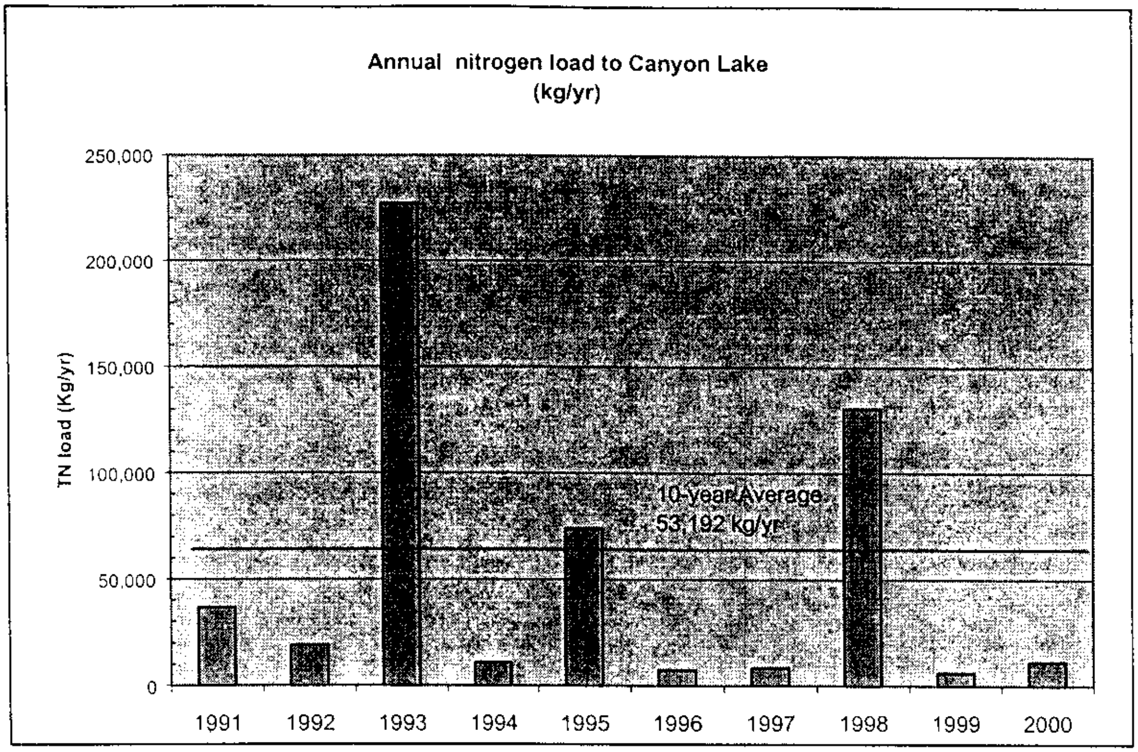


Figure 5-7. Modeled nitrogen load to Canyon Lake from 1991 through 2000 (data from Tetra Tech, 2003)

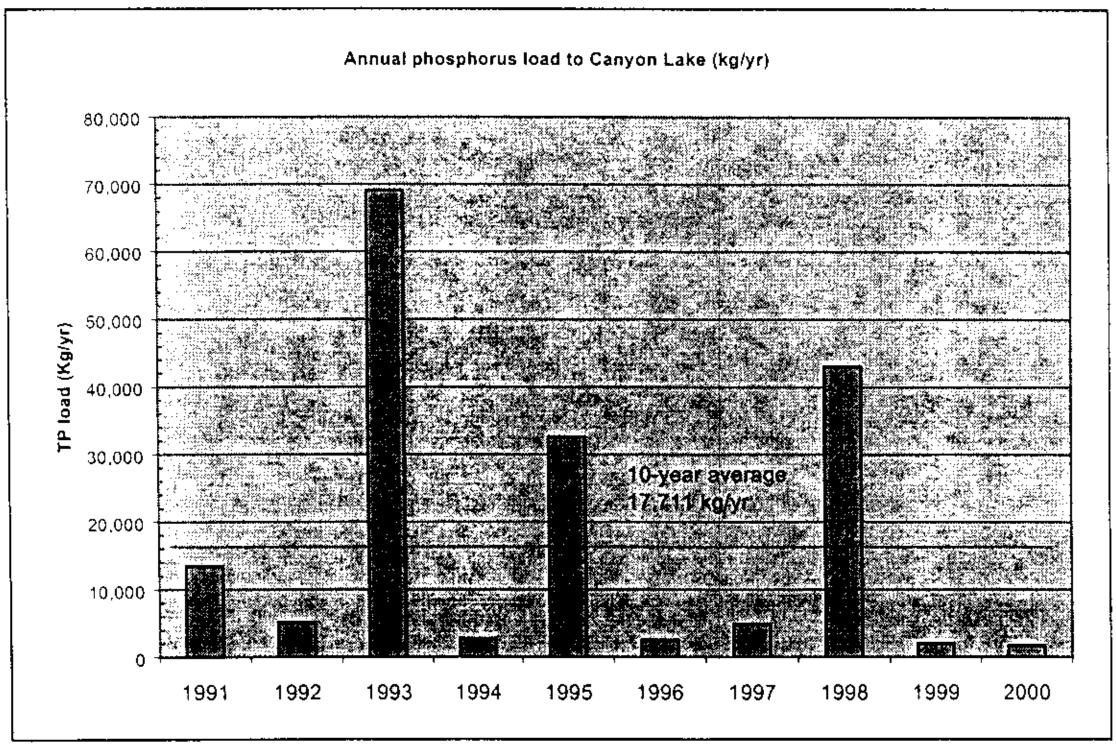


Figure 5-8. Modeled phosphorus load to Canyon Lake from 1991 through 2000 (data from Tetra Tech, 2003)

5.2.2 Nutrient Loading to Lake Elsinore

Nutrient loads to Canyon Lake were routed through the lake using the EFDC model to simulate the nutrients exported to Lake Elsinore. Due to the long time required for running the EFDC model, only three years were simulated to represent the three scenarios discussed previously (Table 5-6). The LSPC model was used to simulate the nutrient loads from the local watershed of Lake Elsinore. The total nutrient loads to Lake Elsinore are the sum of the loads from the local watershed and the load exported from Canyon Lake, as simulated by the EFDC model.

Annual loads of total nitrogen and total phosphorus to Lake Elsinore for each modeled water year are summarized in Table 5-8. Both the nitrogen and phosphorus loads to Lake Elsinore in 1998 (wet year) were more than two orders of magnitude greater than those for the water years 1994 and 2000 (moderate and dry years). As shown in Table 5-8, a significant amount of nutrient input to Lake Elsinore came from Canyon Lake.

Table 5-8. Simulated annual external nutrient loads to Lake Elsinore for three hydrologic scenarios (all numbers in kg/yr)

	Total Nitrogen				Total Phosphorus			
Re-presentative Water Year	Into Canyon Lake	From Canyon Lake	Local Lake Elsinore	Total to Lake Elsinore	Into Canyon Lake	From Canyon Lake	Local Lake Elsinore	Total to Lake Elsinore
1998	130,510	420,133	11,980	432,114	43,031	99,576	1,984	101,559
1994	10,904	17,233	1,329	18,562	2,700	562	227	789
2000	11,485	455	327	781	1,674	414	49	464

Adapted from Tetra Tech, 2003.

5.2.3 Assessment of Spatial and Land Use Loading Effects

Under moderate and dry conditions, the San Jacinto River mainstem does not flow and watershed nutrients are retained in the upper portions of the watershed upstream of Mystic Lake. However, localized sources as well as contributions from areas downstream of Mystic Lake do result in the transport of nutrients to the lakes each year regardless of rainfall amounts. Furthermore, there are cumulative impacts to the lakes due to buildup of nutrients in the upper watershed and the eventual delivery of these nutrients to the lakes.

To analyze the spatial variability in nutrient loading, the San Jacinto River watershed was divided into 9 zones. Figure 5-9 depicts the location of these zones. To easily track the impact of Mystic Lake overflows on nutrient transport, the load from Zone 7 is summarized as the load exported from Mystic Lake. If the load from Zone 7 is zero, Mystic Lake did not overflow and thus, no nutrient load was transported to the lower watershed. As an example, for scenarios II and III identified in Table 5-6 as moderate and dry year conditions, respectively, Zone 7 resulted in no net loading to the lower watershed since Mystic Lake did not overflow. Note that for scenario II and III, upstream nutrient loading is still reported for zones 8 and 9. For these scenarios, the nutrient loads exported from Zones 8 and 9 are stored in Mystic Lake.

Zone 2 nutrient loading to Canyon Lake includes the total loading from upstream, combined with local tributary loading from the area within the Zone 2 boundary, minus the losses resulting from mineralization, groundwater infiltration, and plant uptake. Total watershed nutrient loading to Lake Elsinore is represented by Zone 1 loading that includes the load exported from Canyon Lake and the load from the local area within the Zone 1 boundary. Total nitrogen and total phosphorus loadings for these 9 zones under the 3 simulated hydrological regimes are depicted in Figures 5-10 through 5-15. Relative percentages of nitrogen and phosphorus from the various nutrient sources are also depicted. Note that the nutrient loads are expressed in lbs in these figures, while through out the rest of this document, nutrient loads are expressed in kg. Nutrient loads to Zone 1 are not shown in these Figures because calculation of these loads requires simulation using both the LSPC and EFDC models, which was done only after the construction of the diagrams.

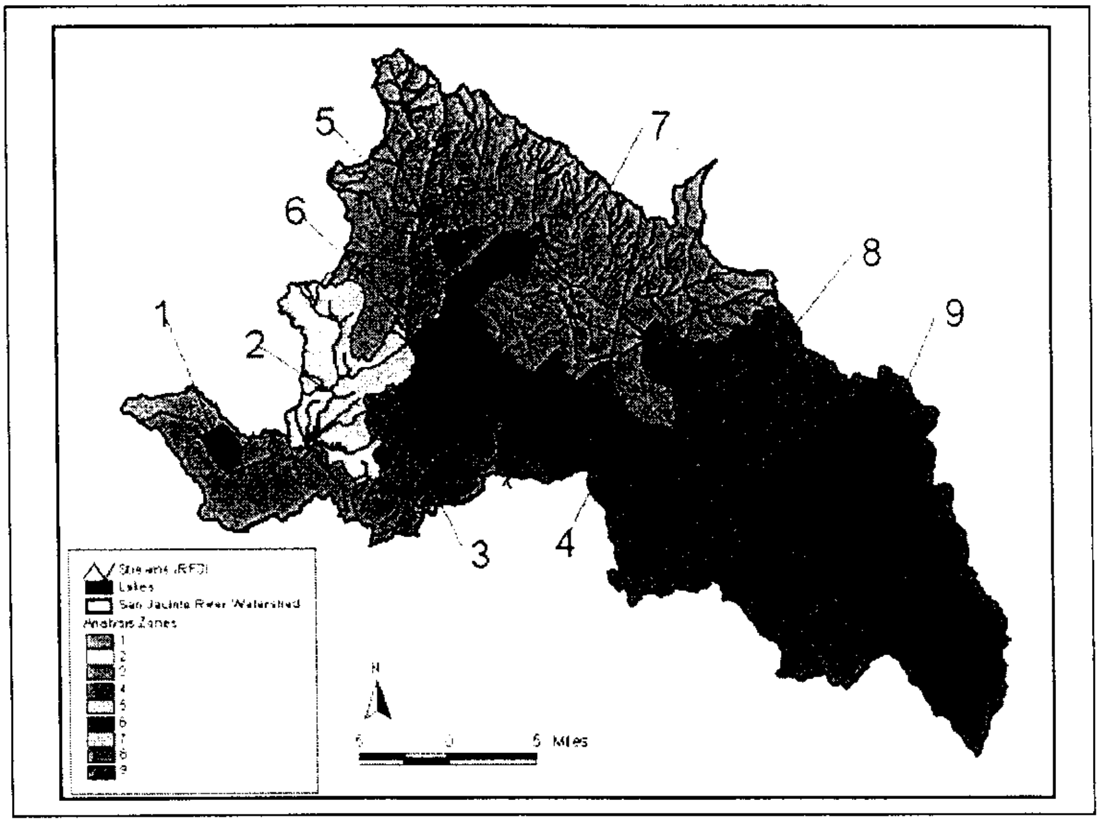


Figure 5-9. Watershed analysis zones (Tetra Tech Inc., 2003)

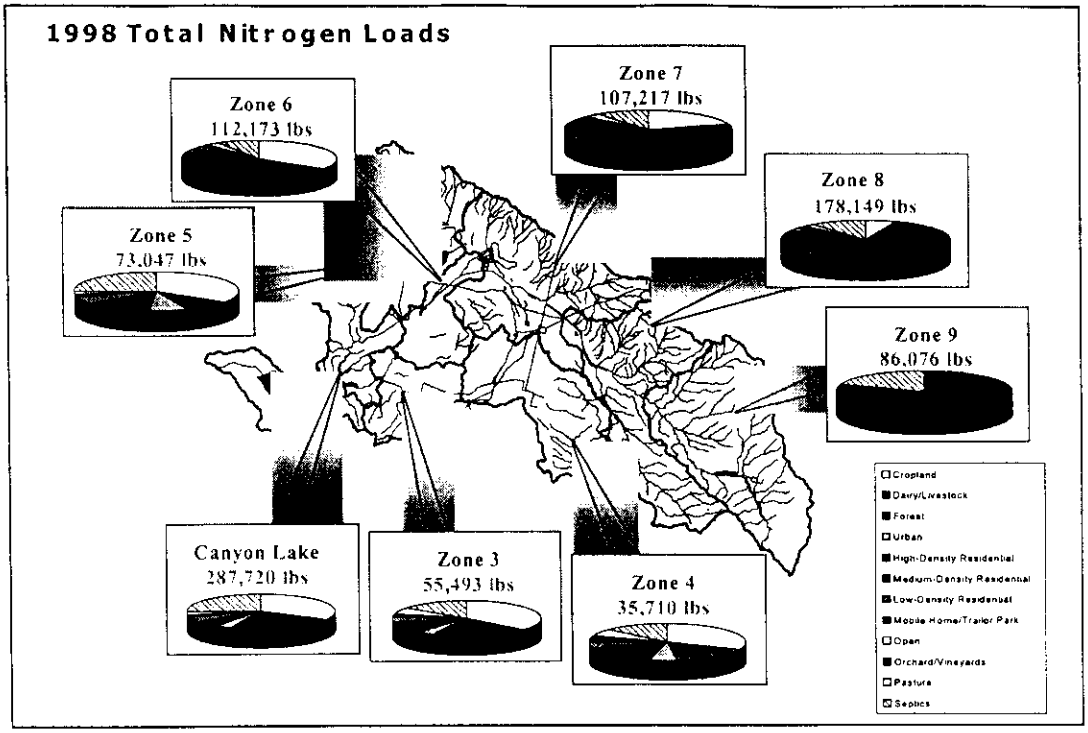


Figure 5-10 Simulated total nitrogen load in 1998 (Scenario I: wet year) (Tetra Tech Inc., 2003)

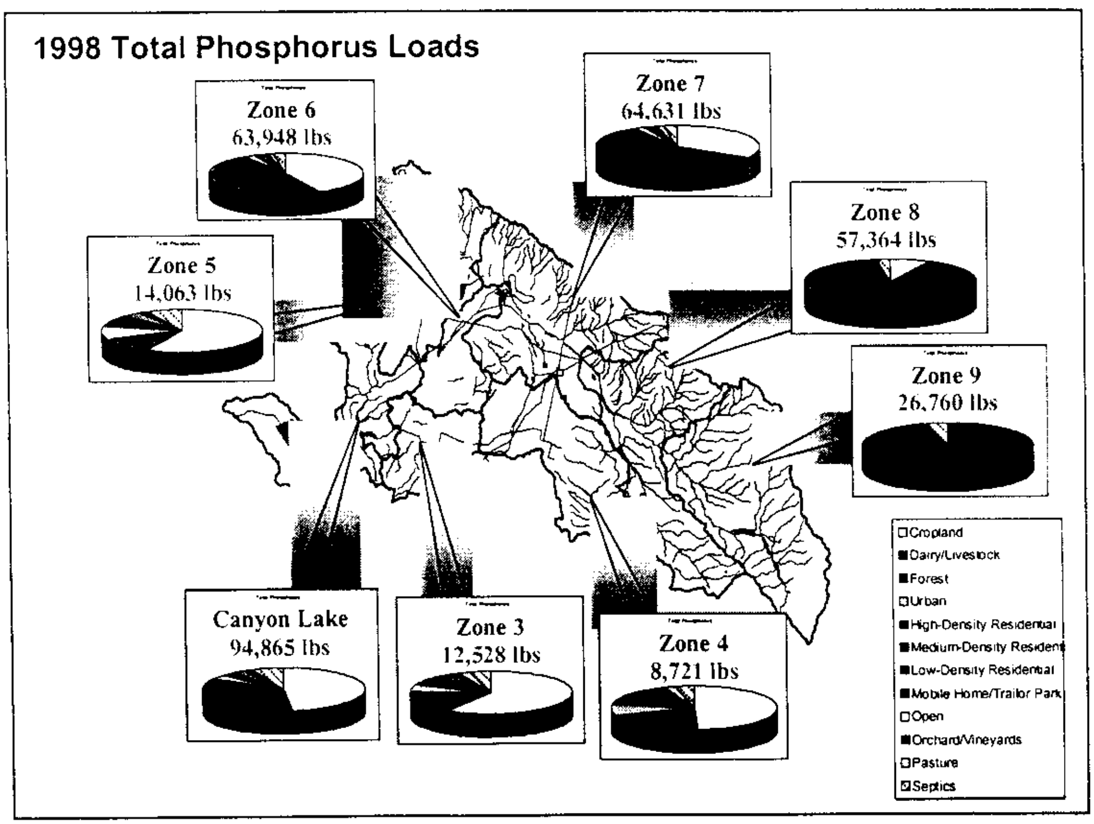


Figure 5-11. Simulated total phosphorus load in 1998 (Scenario I: wet year) (Tetra Tech Inc., 2003)

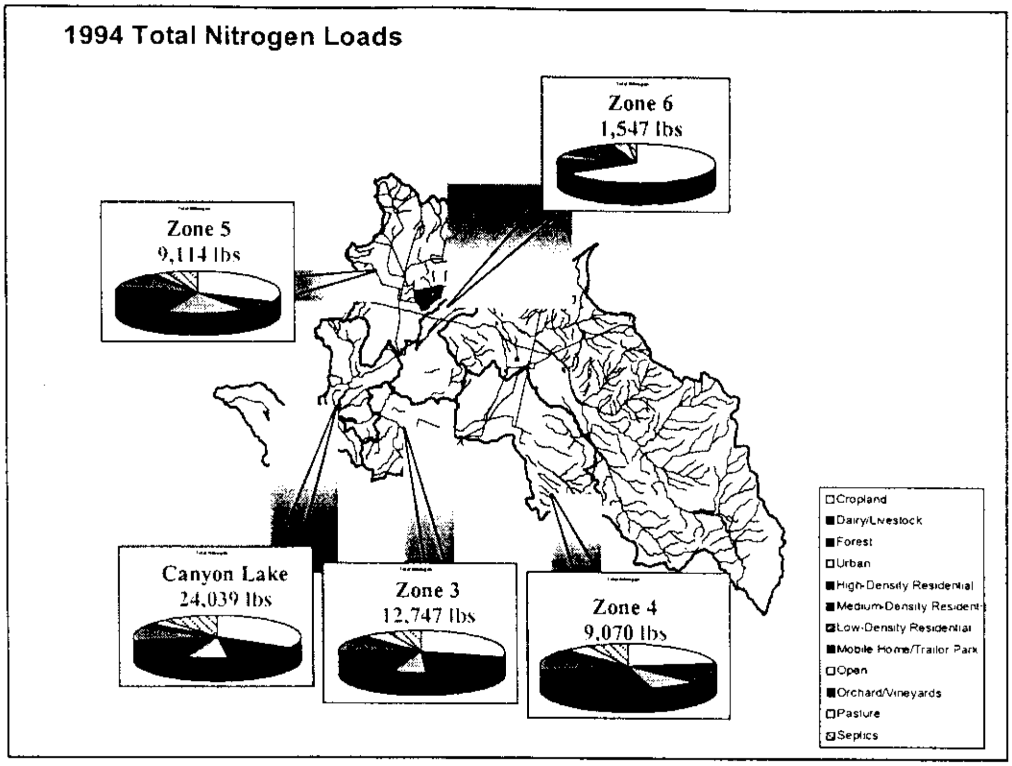


Figure 5-12 Simulated total nitrogen load 1994 (Scenario II: moderate year) (Tetra Tech Inc., 2003)

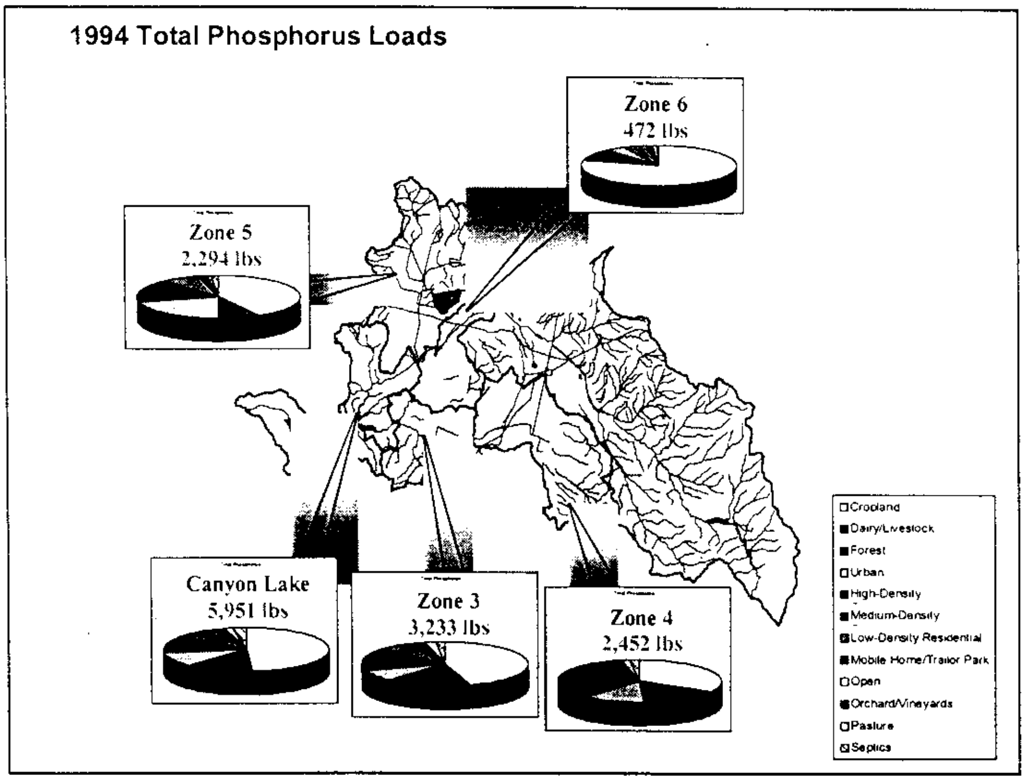


Figure 5-13. Simulated total phosphorus load 1994 (Scenario II: moderate year) (Tetra Tech Inc., 2003)

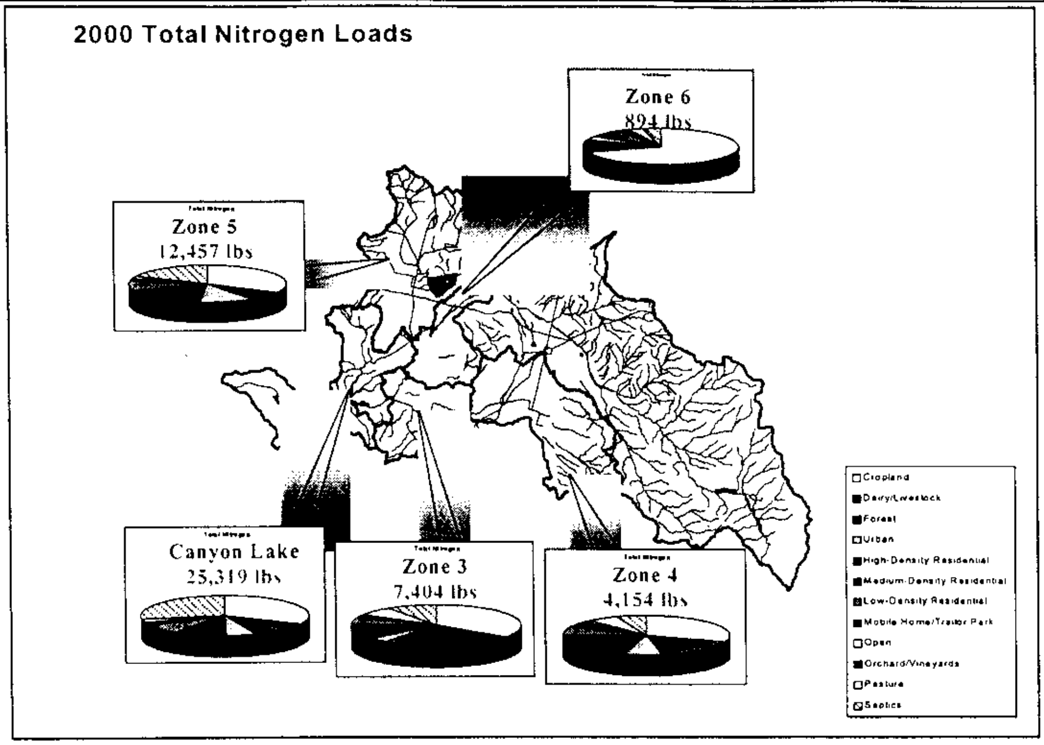


Figure 5-14 Simulated total nitrogen load in 2000 (Scenario III: dry year) (Tetra Tech Inc., 2003)

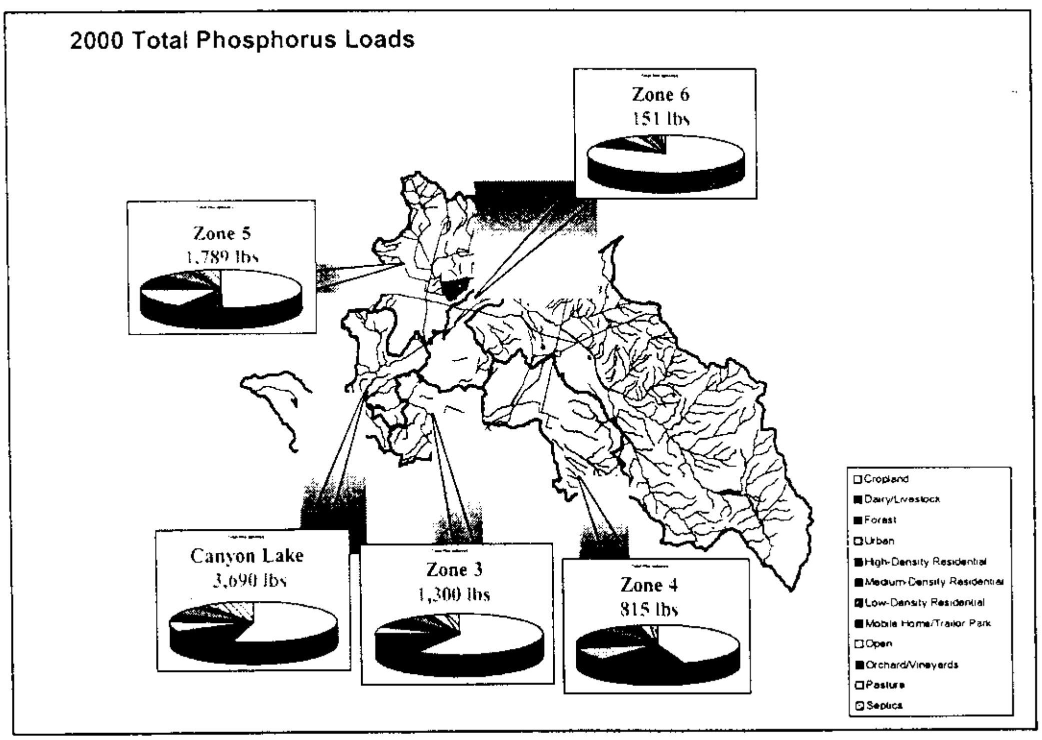


Figure 5-15 Simulated total phosphorus load in 2000 (Scenario III: dry year) (Tetra Tech Inc., 2003)

5.2.4 Assessment of Background Load

To assess the background nutrient loads to Lake Elsinore and Canyon Lake, Tetra Tech, Inc. ran the LSPC model assuming that the entire San Jacinto River watershed had the characteristics of forest land use. The model simulated the nutrient loads to the lakes for the pre-development watershed conditions, i.e., no impacts by human activity. Table 5-9 lists the annual nutrient loads to Canyon Lake and Lake Elsinore under these land use conditions for water years 1994 (moderate), 1998 (wet) and 2000 (dry). These results are also presented in Figures 5-16 and 5-17. Similar to the pattern of existing external loads, the background load of nutrients during a wet year (1998) is much greater than the moderate (1994) and dry years (2000). In addition, as expected, nutrient loads under the pre-development conditions are much less than the existing nutrient loads identified by model simulation. Anthropogenic activities clearly affect the magnitude of nutrient loads to both lakes.

Table 5-9. Annual nutrient loads to Canyon Lake and Lake Elsinore under pre-development and existing conditions (Tetra Tech Inc., 2003) (all numbers in kg/yr)

	Water Year	Pre-development Phosphorus Load	Existing Phosphorus Load	Pre-development Nitrogen Load	Existing Nitrogen Load
Canyon Lake	1994	96	2,700	111	10,904
	1998	19,580	43,031	22,196	130,510
	2000	0	1,674	0	11,485
Lake Elsinore	1994	5	789	12	18,562
	1998	40,759	101,559	62,528	432,114
	2000	0	463	0	781

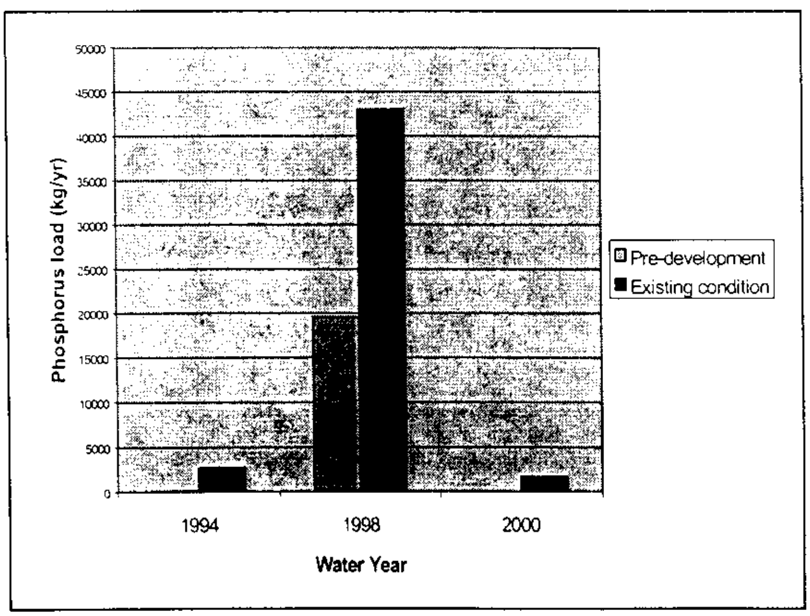


Figure 5-16. Comparison of phosphorus load under pre-development and existing conditions (Data from Tetra Tech Inc., 2003)

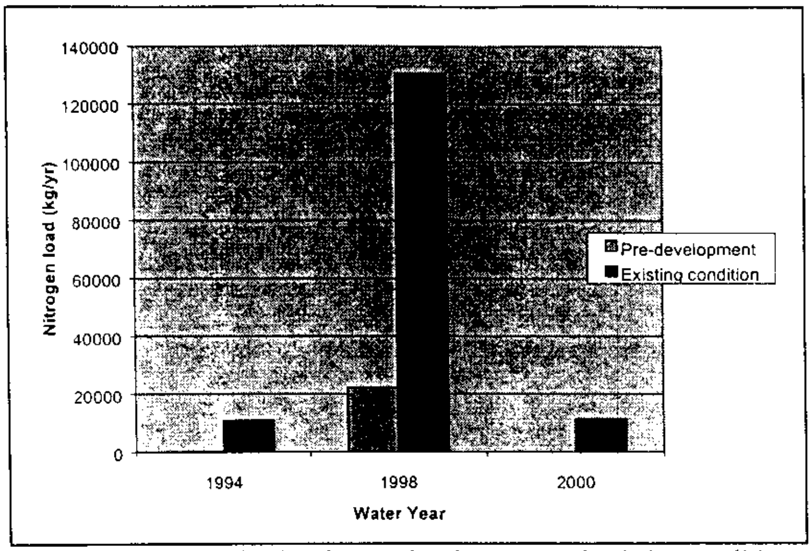


Figure 5-17. Comparison of nitrogen load under pre-development and existing conditions (Data from Tetra Tech Inc., 2003)

5.3 Summary of Nutrient Loads from All Sources

To determine the nutrient contribution from all potential sources, several assumptions had to be made. First, it was assumed that atmospheric deposition is constant for both lakes. Based on studies by Anderson (2001) and Anderson and Oza (2003), atmospheric deposition constituted a very small portion of the year 2000-2001 total nutrient loads to Lake Elsinore and the year 2001-2002 loads to Canyon Lake, irrespective of the amount of precipitation. Therefore the atmospheric deposition rates for nitrogen and phosphorus from these studies were used without adjusting for precipitation for individual years. The phosphorus load from atmospheric deposition was calculated by multiplying the lake surface area with a literature value for wet phosphorus precipitation rate for the study period. Because the studies for Lake Elsinore and Canyon Lake were conducted in two different years, the two wet phosphorus precipitation rates were used. Nitrogen load from atmospheric deposition includes wet precipitation determined in the same fashion as for phosphorus, and dry deposition determined by a study conducted in the Newport Bay watershed (Meixner, 2003, personal communication). This assumption is clearly subject to future refinement based on additional data evaluation during wet years.

Second, it was assumed that the internal nutrient release rate is constant. As discussed in Section 5.2, this assumption needs to be verified with further studies. For the present discussion, the Canyon Lake SRP release rate of 4,625 kg/yr and NH_4-N release rate of 13,549 kg/yr were used for the three scenarios (Anderson and Oza, 2003). For Lake Elsinore, the release rate assumed is 197,370 kg/yr total nitrogen and 33,160 kg/yr total phosphorus (Anderson, 2001).

Third, nutrient sources were aggregated by land use type. Agricultural sources include cropland, orchards/vineyards, and pastures; urban sources include mobile home/trailer parks, industrial facilities and high-density, medium-density, and low-density residential; and CAFO sources are dairy and/or livestock. Open space/forest, septic systems, atmospheric deposition and internal nutrient loading (either from Canyon Lake or Lake Elsinore) are considered as separate categories.

Lastly, the LSPC model was never calibrated for the wet scenario due to the lack of data. The TMDL monitoring program in the watershed has been conducted in the past few years, which have been dry. No data existed for the model to be calibrated for the wet scenario when Mystic Lake spills and upper watershed nutrient loads can be conveyed downstream to Canyon Lake and Lake Elsinore. As a matter of fact, the simulated flow to Lake Elsinore in 1998 was much greater than the measured flow at the USGS gauging station 1107050. Measures have been taken to reconcile the discrepancy. However, until empirical data are collected for the wet condition, the nutrient loads simulated by the LSPC are the best available data and have thus been used in the development of this TMDL.

For the three modeled hydrologic scenarios, Table 5-10 lists the phosphorus and nitrogen loads by all potential sources to both lakes. The nutrient loads from external sources (Agriculture, Urban, CAFO, Open/Forest, and Septic Systems) were simulated by the LSPC model. Internal loading in Lake Elsinore (LE) and Canyon Lake (CL) was derived from the studies by Anderson (2001) and Anderson and Oza (2003). "Export from Canyon Lake" was simulated by the EFDC model (Tetra Tech., Inc., 2003). Limited amount of recycled water (<5000 acre-feet) has been discharged to Lake Elsinore since June 2002 to compensate for water loss through evaporation. Recycled water discharges, authorized pursuant to NPDES permits issued to EVMWD and EMWD, are part of a pilot study to evaluate the impact of increased lake elevation on water quality in Lake Elsinore. The nutrient loads from the recycled water were calculated using the total phosphorus and total nitrogen concentrations of 2 mg/L and 8 mg/L, respectively (Anderson and Nascimento, 2003). A study by CH2M Hill (2004) estimated that Lake Elsinore, on average, needed 3,300 AFY of recycled water to offset the evaporation loss. In the worst-case scenario, the lake needs 8,800 AFY recycled water (CH2M Hill, 2004). An average of 6,500 AFY was used to estimate the amount of nutrients that would have entered the lake if this amount of recycled water were to be discharged into the lake.

Canyon Lake periodically needs supplemental water to maintain the minimum legal requirement of the lake elevation (above 1372'). The source of the water is from the Colorado River water. The data available to staff is the most recent addition in April 2002, when approximately 1006 AF of water was added to Canyon Lake. The measured nitrogen and phosphorus concentrations were 0.2 mg/L and non-detect, respectively (EVMWD, personal communication, 2002). The calculated nutrient load from the supplemental water to Canyon Lake is 248 kg/yr nitrogen (see Table 5-10).

Table 5-10. Total nutrient loads to Canyon Lake and Lake Elsinore for Three Scenarios (all numbers in kg/yr)

Scenario I: Wet Condition - Both Mystic Lake and Canyon Lake Overflowed (WY 1998)

	Total Nitrogen		Total Phosphorus	
Nutrient Sources	Into Canyon Lake	Into Lake Elsinore	Into Canyon Lake	Into Lake Elsinore
Agriculture	47,452	49,014	21,590	21,867
Urban	18,337	20,868	3,885	4,432
CAFO	14,340	14,340	2,875	2,875
Open/Forest	17,591	19,943	12,068	12,857
Septic Systems	32,790	38,326	2,613	2,984
Export from Canyon Lake	NA	289,624	NA	56,545
Internal CL loading	13,549	NA	4,625	NA
Internal LE loading	NA	197,370	NA	33,160
Atmospheric Deposition	1,918	11,702	221	108
Total	144,367	631,524	47,877	134,827

Scenario II: Moderate Condition - Canyon Lake overflowed but Mystic Lake did not overflow (WY1994)

	Total Nitrogen		Total Phosphorus	
Nutrient Sources	Into Canyon Lake	Into Lake Elsinore	Into Canyon Lake	Into Lake Elsinore
Agriculture	4,152	4,375	1,366	315
Urban	3,992	4,390	896	263
CAFO	621	621	53	11
Open/Forest	985	1,334	315	166
Septic Systems	1,155	1,513	76	37
Export from Canyon Lake	NA	6,329	NA	0
Internal CL loading	13,549	NA	4,625	NA
Internal LE loading	NA	197,370	NA	33,160
Atmospheric Deposition	1,918	11,702	221	108
Total	24,761	217,972	7,551	34,059

Scenario III: Dry Condition - Neither Mystic Lake nor Canyon Lake overflowed (WY 2000)

	Total Nitrogen		Total Phosphorus	
Nutrient Sources	Into Canyon Lake	Into Lake Elsinore	Into Canyon Lake	Into Lake Elsinore
Agriculture	4,099	230	931	238
Urban	2,845	201	359	102
CAFO	543	21	29	7
Open/Forest	855	145	196	74
Septic Systems	3,143	184	159	42
Export from Canyon Lake	NA	0	NA	0
Internal CL loading	13,549	NA	4,625	NA
Internal LE loading	NA	197,370	NA	33,160
Atmospheric Deposition	1,918	11,702	221	108
Supplemental Water*	248	59,532	NA	14,883
Total	25,342	240,867	6,520	40,862

(Adapted from Anderson, 2001, Anderson and Oza, 2003, and Tetra Tech Inc., 2003); N/A – not applicable

* A limited amount of recycled water (<5000 acre-feet) has been discharged to Lake Elsinore since June 2002 to compensate for water loss through evaporation. Recycled water discharges, authorized pursuant to NPDES permits issued to EVMWD and EMWD, are part of a pilot study to evaluate the impact of increased lake elevation on water quality in Lake Elsinore.

Figures 5-18 through 5-21 depict the relative contribution of nutrient sources for the three scenarios, a wet year as in 1998, a moderate year as in 1994, and a dry year as in 2000. As shown in Figure 5-18, in 1998, the nitrogen loads estimated by model simulation to enter Canyon Lake were principally from external sources: agriculture (32%), septic systems (22%), urban (13%), open space/forest (12%), CAFOs (10%), and internal sediment loading (9%). By contrast, in a moderate or a dry year, internal loading was the most significant source of nitrogen to Canyon Lake (over 50%). For a moderate year, other significant sources of nitrogen include agriculture (17%), urban (15%), atmospheric deposition (7%), open space/forest, and septic systems (4%). In a dry year, the other sources of nitrogen are agriculture (15%), septic systems (12%), urban (11%), and atmospheric deposition (7%).

As shown in Figure 5-19, phosphorus loads to Canyon Lake in a wet year (1998) came from agriculture (45%), open/forest (25%), internal loading (10%), urban areas (8%), CAFOs (6%) and septic systems (6%). Similar to nitrogen loads, internal loading was the most significant source of phosphorus in a moderate and dry year (61% and 72%, respectively). Other sources of phosphorus to Canyon Lake include agriculture (18%) and urban (12%) in a moderate year. In 2000, 14% of phosphorus came from agriculture, 6% from urban, 3% from atmospheric deposition, 3% from open space/forest, and 2% from septic systems.

As shown in Figure 5-20, in 1998, 46% of the nitrogen load into Lake Elsinore came from export from Canyon Lake. As explained previously, this load was determined using the EFDC model output, which was calibrated to the water column concentration at one sampling station in Canyon Lake. This may represent the flushing effect of Canyon Lake during wet years. Canyon Lake may have been flushed several times depending on the volume of water flowing through Canyon Lake; nutrients in the water column as well as in the sediments in Canyon Lake were washed down to Lake Elsinore. Internal loading was the second largest source of nitrogen (31%) to Lake Elsinore in 1998. Other sources of nitrogen to Lake Elsinore include agriculture (8%), septic systems (6%), urban (3%), open space/forest lands (3%), and CAFOs (2%). In a moderate year as in 1994, approximately 90% of the nitrogen load to Lake Ellsinore came from internal loading. Other less significant sources include atmospheric deposition (5%), export from Canyon Lake (3%), agriculture (2%), and urban (2%). In a dry year (2000), 94% of nitrogen load came from internal loading and 6% from atmospheric deposition. The nitrogen load from recycled water discharges was included in Figure 5-20 to show that 22% of the nitrogen would have been from the reclaimed water had the 6050 AFY of recycled water been added to the lake in 2000. (As noted in Table 5-10, these discharges did not commence until 2002, and the discharge amount is less than 5000AF.)

A similar distribution pattern is observed for phosphorus loading to Lake Elsinore (Figure 5-21). In a wet year like 1998, 42% of the phosphorus loads to Lake Elsinore were transported from Canyon Lake, and 25% came from internal loading from Lake Elsinore sediments. Other sources of phosphorus include agriculture (16%), open space/forest land (10%), urban (3%), septic systems (2%), and CAFOs (2%). Once again, in moderate and dry years, the most significant source of phosphorus to Lake Elsinore is internal loading. Other sources of phosphorus in a moderate year include export from Canyon Lake (3%), agriculture (2%), and urban (2%). The phosphorus load from recycled water was included in Figure 5-21 to show that recycled water would have contributed 31% of the total phosphorus load to Lake Elsinore had it been discharged in 2000.

In all modeled scenarios, phosphorus loading from atmospheric deposition was not significant (generally less than 1% of the total load). Under moderate and dry conditions, atmospheric deposition makes up 7% of the total nitrogen load to Canyon Lake, and 5% of the total nitrogen load to Lake Elsinore.

The distinctly different distribution of nutrient loads to Lake Elsinore and Canyon Lake under wet and dry conditions seems to suggest that different load allocation schemes would maximize effective water quality improvements in both lakes. Under wet conditions, sources in the San Jacinto River watershed such as agriculture, septic systems and urban areas contribute significant amounts of nutrients to Canyon Lake based on the LSPC model simulations by Tetra Tech (2003). For Lake Elsinore, however, export of nutrients from Canyon Lake and internal loading from Lake Elsinore sediments are the dominant sources of nutrients. Further, under dry conditions (2000), lake sediments are the dominant source of nutrients for both Lake Elsinore and Canyon Lake. This phenomenon was independently confirmed by studies of sediment characterization and nutrient release rate determination by Anderson (2001), and Anderson and Oza (2003).

While separate load allocation schemes based on hydrologic condition would arguably be most appropriate, they would be difficult to implement. Implementation would require an accurate prediction of hydrological condition in any given year in order to decide which allocation scheme must be met. Furthermore, separate load allocation schemes would not take into account the cumulative nature of nutrient inputs under the variety of hydrologic conditions. As previously discussed, nutrient loads are accumulated in the lakes and have a prolonged effect on water quality that is not limited to any particular hydrologic condition. To address both these concerns, a TMDL approach based on 5-year average loads is recommended (see Sections 6.0 and 7.0). The average nutrient loads from sources based on all three hydrological conditions are shown in Table 5-11. As discussed next, the average loads will be allocated among the sources. The allowable loads for each source will then be compared to the existing, average load for each source to determine the reductions that will be required to meet the recommended numeric targets.

Table 5- 11 Total nutrient loads to Canyon Lake and Lake Elsinore (Average of the three scenarios) (all numbers in kg/yr)

Nutrient Sources	Total Nitrogen Into Canyon Lake	Total Nitrogen Into Lake Elsinore	Total Phosphorus Into Canyon Lake	Total Phosphorus Into Lake Elsinore
Agriculture	18,567	17,873	7,962	7,473
Urban	8,391	8,486	1,713	1,599
CAFO	5,168	4,994	986	964
Open/Forest	6,477	7,141	4,193	4,366
Septics	12,362	13,341	949	1,021
Export from Canyon Lake	NA	98,651	NA	18,848
Internal CL loading*	13,549	NA	4,625	NA
Internal LE loading*	NA	197,370	NA	33,160
Atmospheric Deposition	1,918	11,702	221	108
Supplemental water+	248	59,532	NA	14,883
Total of External Sources	*53,132*	*221,720*	*16,024*	*49,262*
Total	66,680	419,090	20,649	82,422

* Internal loading values are based on studies by Anderson (2000 for Lake Elsinore) and Anderson and Oza (2003 for Canyon Lake) and are assumed to be constant.

\+ Nutrient loads from supplemental water for Lake Elsinore are calculated by using 6050 AFY recycled water and the reported nutrient concentrations, and are assumed constant.

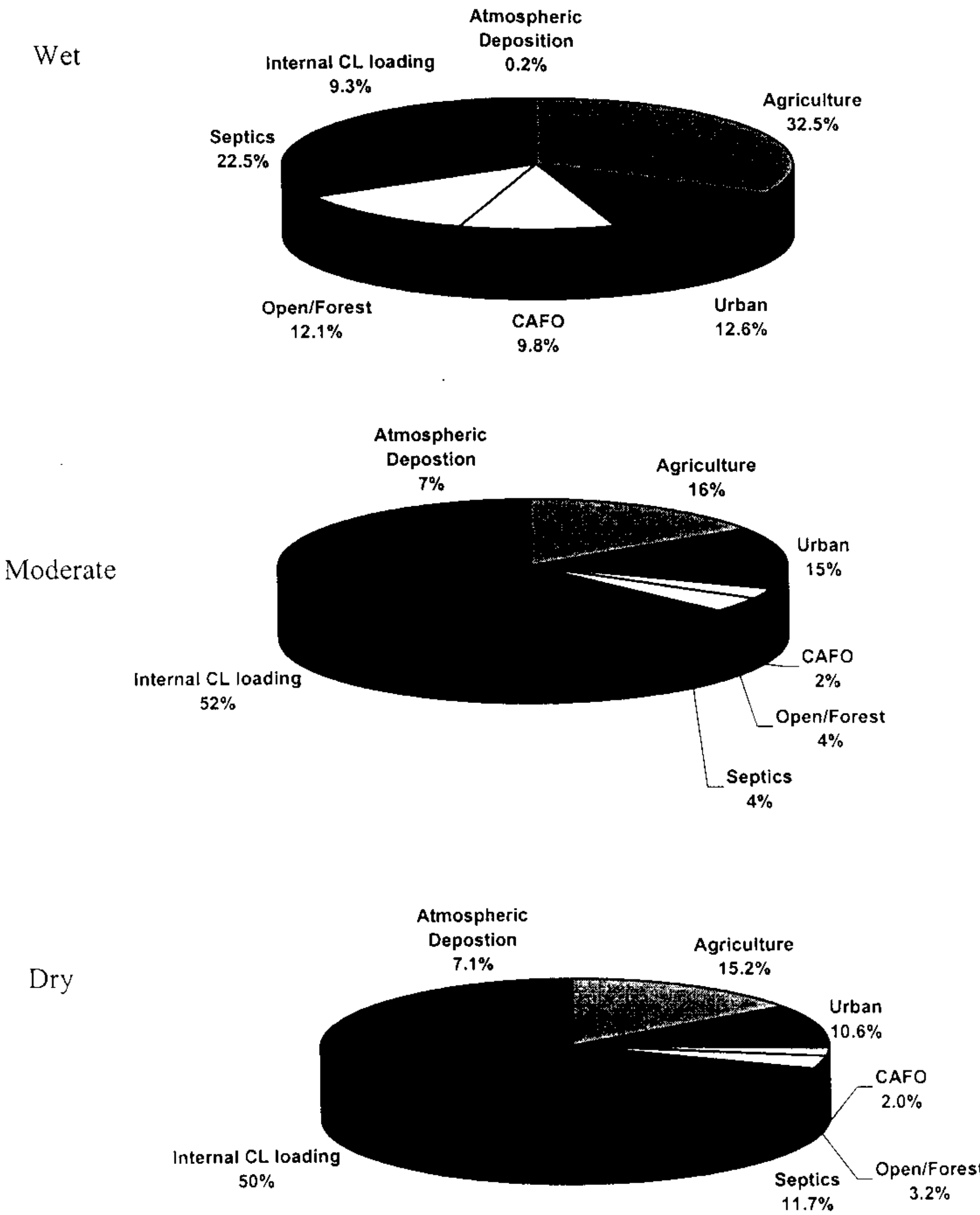


Figure 5-18. Total nitrogen load to Canyon Lake under three scenarios: wet year as in 1998 (top), moderate year as in 1994 (middle), and dry year as in 2000 (bottom) (see Table 5-10)

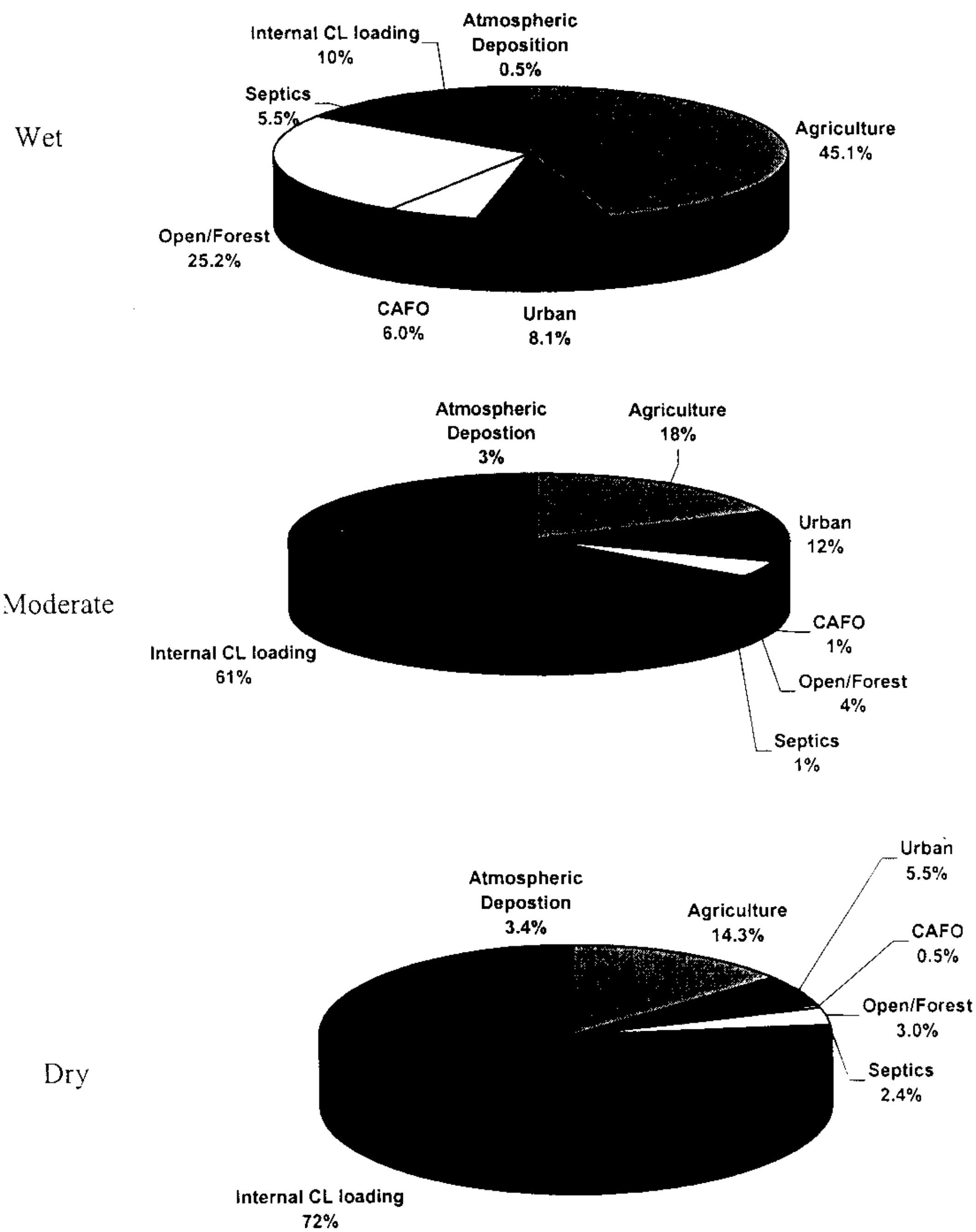


Figure 5-19. Total phosphorus load to Canyon Lake under three scenarios: wet year as in 1998 (top), moderate year as in 1994 (middle), and dry year as in 2000 (bottom) (see Table 5-10)

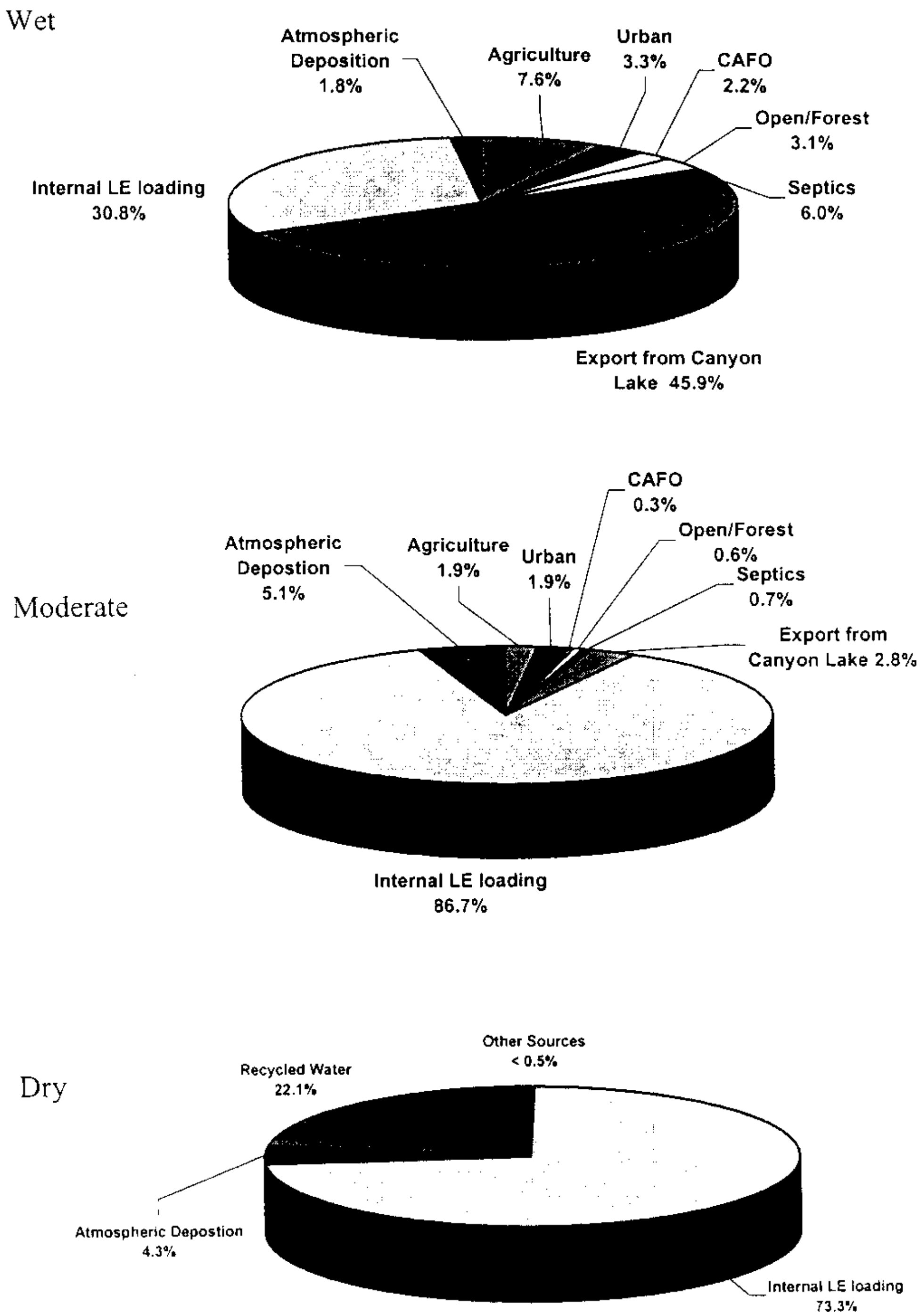


Figure 5-20. Total nitrogen load to Lake Elsinore under three scenarios: wet year as in 1998 (top), moderate year as in 1994 (middle), and dry year as in 2000 (bottom) (see Table 5-10)

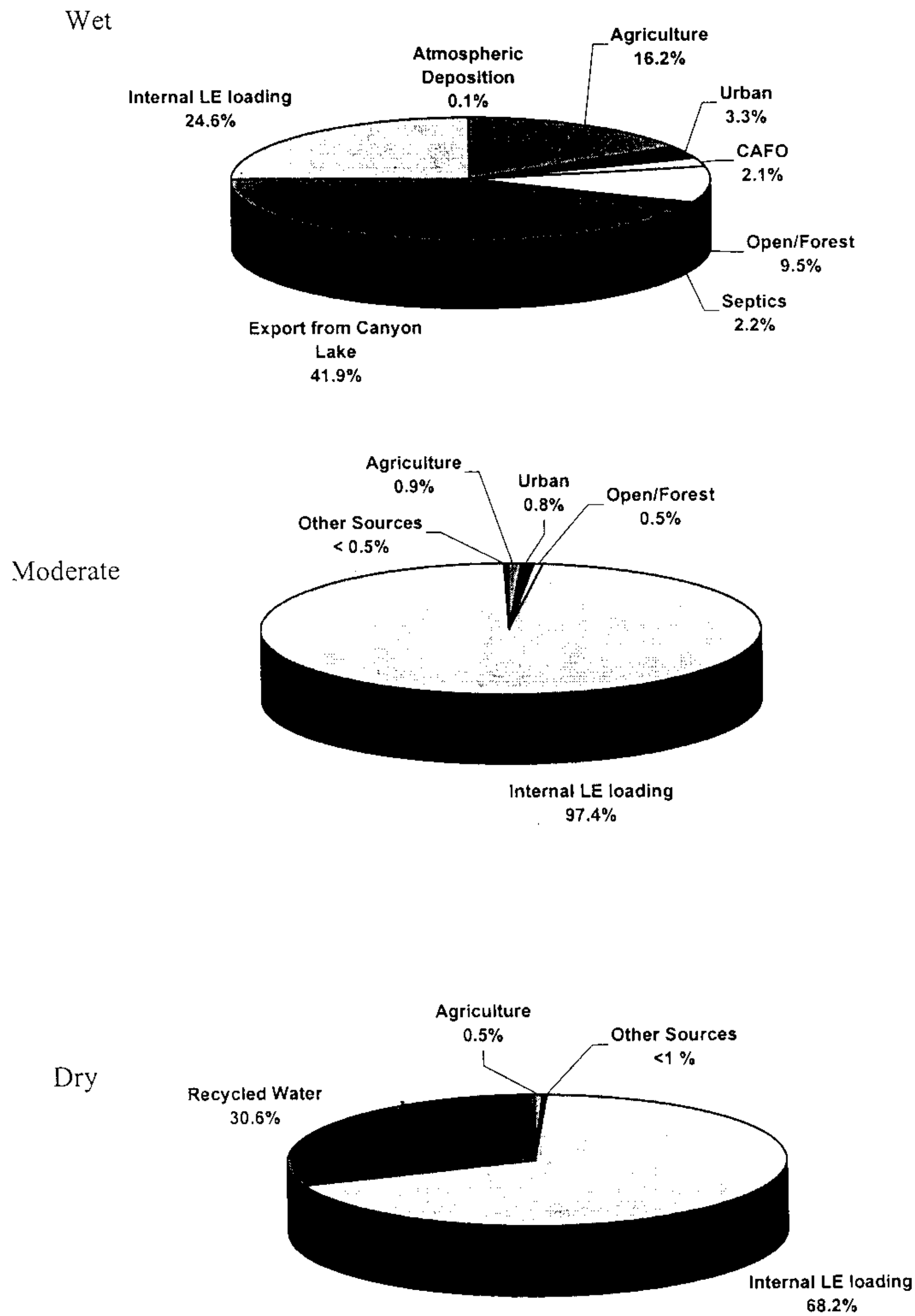


Figure 5-21. Total phosphorus load to Lake Elsinore under three scenarios: wet year as in 1998 (top), moderate year as in 1994 (middle), and dry year as in 2000 (bottom) (see Table 5-10)

6. Linkage Analysis and TMDL (Load Capacity)

The linkage analysis component of the TMDL establishes the relationship between nutrient loading and numeric targets and defines the total maximum daily load (TMDL) or loading capacity of receiving waters in order to determine the reductions required to attain the desired water quality (as expressed by the numeric targets (US EPA, 1999)). The linkage can be based on a long-term set of monitoring data that allow for an evaluation of waterbody response to flow and loading conditions. However, if the data are not available to develop this relationship, linkage can be established by the use of analytical tools (including simulation models) and/or best professional judgment.

In order to determine the phosphorus TMDL (load capacity) for both Lake Elsinore and Canyon Lake, models used to predict the annual and seasonal phosphorus concentrations in stratified and polymictic lakes (shallow lakes that mix every few days or even daily all year round) (Nürnberg, 1998), were evaluated for applicability. These models and methods proved to be not applicable to Lake Elsinore and Canyon Lake due to the extremely long hydraulic residence time for both lakes. Another common lake model, BATHTUB, has been used in the past to simulate the water quality for both lakes (Anderson, 2001, Anderson and Oza, 2003). For Lake Elsinore, the BATHTUB model simulated phosphorus concentration adequately close to the measured results for year 2000-2001; however, the model could not accurately simulate phosphorus and nitrogen concentrations for other years and other hydrological conditions. For Canyon Lake, the BATHTUB model poorly predicted the water quality, even for the 2001-2002 period when the nutrient budget was developed. In addition, the BATHTUB model requires input of nutrient budget data that were not available for either lake, other than the two specific years when the nutrient budgets were developed. The BATHTUB model also assumes a constant internal loading rate not dependent on water column concentration. However, a preliminary study by Anderson (2002) has shown that the water column phosphorus concentrations positively correlate to the internal phosphorus loading. For these reasons, to develop the nutrient TMDLs for Lake Elsinore and Canyon Lake, staff relied on nutrient mass balance models developed specifically for the lakes based on historical data. Similar nutrient mass balance models have also been used for other lake TMDLs (e.g., Walker, 2000).

6.1 Lake Elsinore Total Phosphorus (TP) Concentration Model

Using historical water quality data from 1992-1997 and 2000-2002, Dr. Anderson developed a simple steady-state phosphorus (referred to as TP) model for Lake Elsinore in order to determine the allowable phosphorus load to meet numeric targets under various loading scenarios (Anderson, 2002). A discussion of the derivation and verification of the model is presented in Appendix B.

For moderate and dry conditions, under steady-state conditions, i.e., no change in the lake volume and no change in the water column concentration (as represented by the proposed numeric target), the allowable external load to Lake Elsinore is represented by equation 1:

Equation 1: $Q_{in}C_{in}$ (external TP load) = $(C_{ss}\, v_s - (k+r)\, C_{sed}) * V/H$

where:

Q_{in} = flow entering Lake Elsinore (m^3/yr)
C_{in} = TP concentration entering Lake Elsinore (mg/L)
C_{ss} = in-lake TP concentration (mg/L) ***(numeric target)***
v_s = phosphorus settling rate of 37.4 m/yr
k = internal TP loading rate of 0.0156 m/yr
r = TP re-suspension velocity of 0.0021 m/yr
C_{sed} = volumetric sediment TP concentration of 247,000 mg/m^3
V = lake volume of (m^3)
H = average lake depth (m)

This equation links external load ($Q_{in}C_{in}$) and internal load (represented as $((k+r)C_{sed})$ to in-lake TP concentration (C_{ss}) and can be used to calculate the nutrient loading capacity for the proposed numeric targets. Estimates for the constants v, k, r, and C_{sed} are based on historical data and recent studies (Anderson, 2002). Substituting the values for settling rate (v_s), internal TP loading rate (k), TP re-suspension rate (r) and sediment TP concentration (C_{sed}) which are assumed to be constant, yields a linear relationship between the C_{ss} (TP numeric target) and the TP load capacity ($Q_{in}*C_{in}$) as shown in equation 2.

Equation 2: $Q_{in}C_{in}$ (external TP load, in kg/yr) = (37.4*TP target – 4371.9) * V/H*10^{-6}

Phosphorus Load Capacity for Lake Elsinore Based on Proposed Interim Target

Substituting the proposed interim phosphorus numeric target of 0.1 mg/L (or 100 mg/m^3) into equation 2 results in an external TP load ($Q_{in}*C_{in}$) that has to be negative in order to meet the proposed numeric target. This means that without any reduction in internal load, it would be impossible to achieve the numeric target even when the external load is zero. Assuming that there is no external TP load entering Lake Elsinore, the internal loading rate (k), would have to be reduced from the current rate of 0.0156 m/yr to 0.013 m/yr., a 16 % reduction to achieve the proposed numeric target of 0.1 mg/L. Put another way, **in order to achieve the proposed TP numeric target of 0.1 mg/L, no external phosphorus load into Lake Elsinore can be allowed <u>and</u> at the same time, the internal sediment phosphorus load would need to be reduced by 16% under moderate and dry conditions.**

Staff does not believe that it is feasible to restrict all external loads to Lake Elsinore. In addition, under dry conditions, the predominant source of nutrients is the lake sediment. It is expected that Lake Elsinore water quality will not improve unless there is a significant reduction in internal loading. Staff evaluated methods to reduce the internal sediment loading. Limnocosm experiments on Lake Elsinore showed that alum was the most effective treatment for reducing the internal loading of phosphorus, completely stopping phosphorus release from the sediments over several months (Anderson, 2000). However, additional studies show that for Lake Elsinore as a whole, alum treatment is not feasible at the present due to the high pH of the Lake (Anderson, 2001). Calcium addition reduced ortho-phosphate (PO_4-P) flux by 65%. But this effect is considered to be short-term, and the long-term efficacy of calcium treatment is unknown. Aeration to maintain the dissolved oxygen at or near 7 mg/L, reduced PO_4-P release by 35% (Anderson, 2000). Currently, an aeration system is being planned for Lake Elsinore by LESJWA. Therefore, staff is using the 35% phosphorus reduction rate for the expected reduction in the internal sediment load to calculate the phosphorus load capacity in order to achieve the interim target.

Table 6-1 lists the allowable external total phosphorus load to Lake Elsinore in order to achieve the interim phosphorus target of 0.1 mg/L, assuming the 35% reduction in internal loading of phosphorus. As shown, the allowable external load is correlated with lake elevation and volume: as the lake elevation and volume increase, greater amounts of phosphorus can be discharged to Lake Elsinore and still ensure that the proposed interim phosphorus numeric target of 0.1 mg/L will be met. These results are presented graphically in Figure 6-1.

For wet conditions when Lake Elsinore overflows to Temescal Creek, as occurred in 1993, 1995 and 1998, the allowable total phosphorus load can be expressed by equation 3:

Equation 3:
$$Q_{in}C_{in}\ (\text{external TP load in kg/yr}) = Q_{out}C_{out} + ((\text{TP target} * v_s - (k+r)\ C_{sed}) * V/H$$

where:
Q_{in} = flow entering Lake Elsinore (m^3/yr)
C_{in} = TP concentration entering Lake Elsinore (mg/L)
C_{ss} = in-lake TP concentration (mg/L) ***(numeric target)***
v_s = phosphorus settling rate of 37.4 m/yr
k = internal TP loading rate of 0.0156 m/yr
r = TP re-suspension velocity of 0.0021 m/yr
C_{sed} = volumetric sediment TP concentration of 247,000 mg/m^3
V = lake volume of (m^3)
H = average lake depth (m)
Q_{out} = outflow leaving Lake Elsinore
Q_{in} = TP concentration of the outflow (in-lake TP concentration is used)

The only available data for overflows from Lake Elsinore were obtained during rainfall events in 1995. Q_{out} was 26,815 acre-feet (or 33,000,000 m^3/yr), C_{out} was = 0.1 mg/L, and the lake elevation was 1255 ft. Again, assuming an aeration system will reduce the internal sediment phosphorus loading rate (k) by 35%, the allowable TP load from external sources is then calculated to be 13,726 kg/yr (Table 6-1). This translates to a 32% increase of the allowable TP load compared to the TP load calculated under conditions when Lake Elsinore does not overflow (*e.g*, 10,428 kg/yr at 1255', no spill).

Table 6-1. Total external phosphorus TMDL for Lake Elsinore to achieve interim TP target of 0.1 mg/L after 35% reduction in internal loading rate

Elevation* (ft)	Volume (AF)	Volume (m^3)	Average Depth (ft)	Average Depth (m)	TP TMDL (kg/yr)
1230	12,000	14,760,000	5.2	1.6	6,670
1240	38,519	47,378,370	12.5	3.8	8,907
1250	71,443	87,874,890	20.6	6.3	10,024
1255	89,114	109,610,220	24.7	7.5	10,428
Lake Elsinore spills at greater than 1255'					13,726
Average					**9,951**

* Typical Lake Elsinore elevation under wet conditions is 1250' or greater. Under moderate conditions, the lake elevation ranges from 1245 to 1250'; under dry conditions, lake elevation is below 1245' (or completely dry).

It is important to note that these calculations do not take into account the cumulative effect of nutrient loads on the lake. For example, as just explained, the nutrient loads that can be discharged to the lake are higher during wet weather, when additional flow and lake volume result in compliance with the target phosphorus concentrations. However, this overlooks the fact that the nutrient loads contributed in wet weather have the potential to remain in the lake, where they may provide an ongoing source of internal nutrient loading. A TMDL approach that fails to account for these cumulative effects would frustrate efforts to reduce internal nutrient loading. Thus, Table 6-1 also specifies the average nutrient loads necessary to achieve the interim phosphorus target. Use of average loads will help to address cumulative effects and, as discussed at the end of Section 5, will facilitate implementation of the TMDL and determination of compliance.

Phosphorus Load Capacity for Lake Elsinore Based on the Proposed Final Target

Similarly, substituting the proposed final phosphorus numeric target of 0.05 mg/L (or 50 mg/m^3) into equation 2 results in an external phosphorus load (Q_{in}*C_{in}) that has to be negative in order to meet the proposed numeric target. Assuming that there is no external phosphorus load entering Lake Elsinore, the internal loading rate (k) would have to be reduced from the current rate of 0.0156 m/yr to 0.0055 m/yr, a 65 % reduction, to achieve the proposed numeric target of 0.05 mg/L. To allow any external phosphorus loading into Lake Elsinore, a greater than 65% reduction in phosphorus internal loading rate has to be achieved. Literature review has shown that alum treatment has a long-term effect (10-20 year) of reducing the internal phosphorus loading rate by 70% (Welch and Cooke, 1999). Assuming that alum treatment becomes feasible in the future for Lake Elsinore, and/or that other in-lake treatments, separately or cumulatively, reduce the internal phosphorus loading rate by 70% (k of 0.00468 m/yr), the allowable external load to Lake Elsinore in order to achieve the proposed final phosphorus target of 0.05 mg/L was calculated for different lake elevations/volumes (Table 6-2). These results are presented graphically in Figure 6-2. As for the interim target, the average load needed to comply with the proposed final target is also shown in Table 6-2.

Figure 6-2 shows that even with a 70% reduction in the internal loading rate, the allowable phosphorus load from external sources (load capacity) to Lake Elsinore would need to be very small to achieve the proposed 0.05 mg/L final phosphorus target. Recognizing the uncertainty and difficulty of both achieving a 70% internal phosphorus loading reduction and essentially eliminating external phosphorus loading, 0.05 mg/L of phosphorus is proposed as a long-term target, with compliance to be achieved by 2019. However, staff believes that compliance with the proposed interim target of 0.1 mg/L is achievable in the relatively short term, in light of the expected implementation of an aeration system for the lake.

Table 6-2.Total external phosphorus TMDL for Lake Elsinore to achieve final TP target of 0.05 mg/L after 70% reduction in internal load rate

Elevation* (ft)	Volume (AF)	Volume (m^3)	Average Depth (ft)	Average Depth (m)	TP TMDL (Kg/yr)
1230	12,000	14,760,000	5.2	1.6	1,818
1240	38,519	47,378,370	12.5	3.8	2,428
1250	71,443	87,874,890	20.6	6.3	2,732
1255	89,114	109,610,220	24.7	7.5	2,842
1260	107,877	132,688,710	27.8	8.5	3,057
Lake Elsinore spill at greater than 1255'					4,491
Average					**2,895**

* Typical Lake Elsinore elevation under wet conditions is at 1250' or greater. Under moderate conditions, the lake elevation ranges from 1245 to 1250'; under dry conditions, lake elevation is below 1245' (or completely dry).

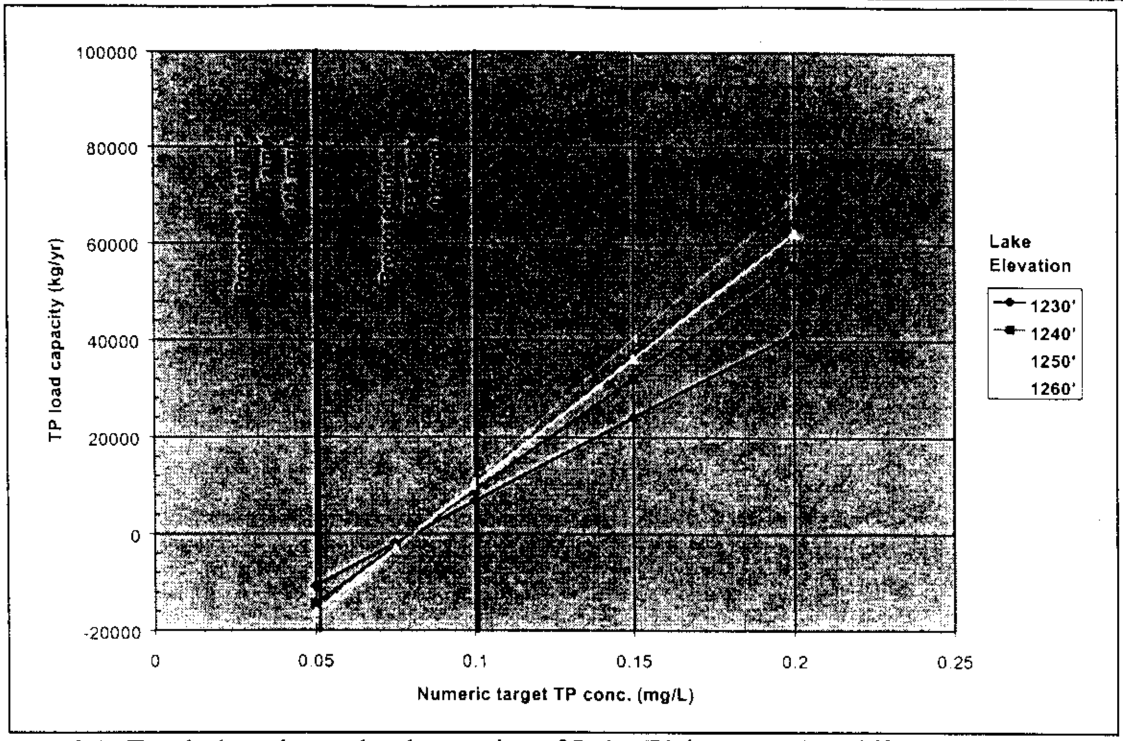


Figure 6-1. Total phosphorus load capacity of Lake Elsinore under different in-lake total phosphorus concentrations assuming 35% reduction in internal loading rate

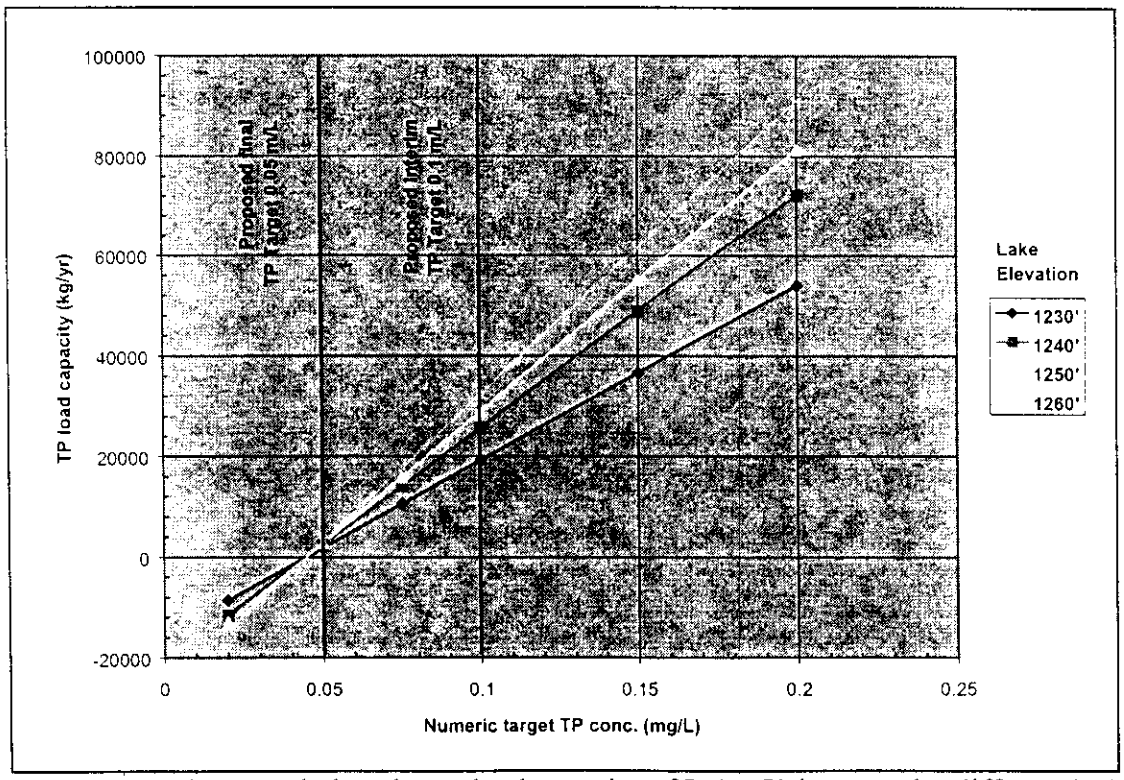


Figure 6-2. Total external phosphorus load capacity of Lake Elsinore under different in-lake total phosphorus concentrations assuming 70% reduction in internal loading rate

6.2 Canyon Lake Total Phosphorus Concentration Model

In order to make water quality predictions and establish the link between phosphorus loadings to Canyon Lake and in-lake total phosphorus concentrations, a simplified steady-state model similar to the model developed for Lake Elsinore was also developed for Canyon Lake.

$$\mathbf{C_{ss} = ((Q_{in}C_{in} - Q_{out}C_{out})/V)*H/v_{net}}$$

solving for the allowable external TP load ($Q_{in}C_{in}$):

$$\mathbf{Q_{in}C_{in}\ (external\ TP\ load) = C_{ss} * v_{net} *V/H + Q_{out}C_{out}}$$

where:
Q_{in} = flow entering Canyon Lake (m^3/yr)
C_{in} = TP concentration entering Canyon Lake (mg/L)
C_{ss} = in-lake TP concentration (mg/L) ***(numeric target)***
v_{net} = phosphorus sedimentation rate (m/yr)
V = lake volume of (m^3)
H = average lake depth (m)
Q_{out} = outflow from Canyon Lake (m^3/yr)
C_{out} = TP concentration leaving Canyon Lake (mg/L)

The net sedimentation rate of phosphorus, (v_{net}), was determined from historical phosphorus concentration data, and reflects the loss of phosphorus by algal uptake and sedimentation minus internal loading and re-suspension. Unlike Lake Elsinore, the relationship between phosphorus net sedimentation rate, sediment phosphorus release rate and re-suspension rate for Canyon Lake could not be developed for Canyon Lake because of the lack of data.

In Canyon Lake during the spring of 1998, fall of 1998, fall of 2000, spring of 2001 and fall of 2001, the TP concentration displayed a first order rate decay. The rate constants were calculated by fitting an exponential curve to each time period, yielding an average first order rate constant of 0.91/yr. Since rate constant = v_{net} /H, and the average water depth of Canyon Lake (H) during 1998, 2000 and 2001 was 7 m, v_{net} is then calculated to be 6.4 ± 0.8 m/yr. During dry years, the outflow (Q_{out}) from Canyon Lake is equal to zero. Outflows from Canyon Lake during wet and moderate years (as represented by 1998 and 1994, respectively) predicted by the EFDC model were used to provide Q_{out} values of 133,981 and 2,641 acre-feet, respectively.

Phosphorus Load Capacity for Canyon Lake Based on Proposed Interim Target

Substituting the proposed interim phosphorus numeric target of 0.1 mg/L (or 100 mg/m^3) into the above equation results in an external TP load ($Q_{in}*C_{in}$) for Canyon Lake under various lake elevations (Table 6-3). Phosphorus load capacity increases significantly in wet years (1998), while during moderate conditions (1994), the total phosphorus load capacity only slightly increases as compared to dry conditions (Table 6-3). As for Lake Elsinore, these calculations fail to take into account the cumulative effect of nutrient loads on water quality and again, an average load approach is recommended. The average loads needed to assure compliance with the numeric targets are also shown in Table 6-3.

Table 6-3. Total external phosphorus TMDL for Canyon Lake to achieve the proposed interim target of 0.1 mg/L (for external load only)

Elevation* (feet asl)	Volume (AF)	Volume (m^3)	Area (acres)	Mean Depth (feet)	Mean Depth (m)	TP TMDL (kg/yr)
1372	7,152	8,796,960	426	16.79	5.1	1,099
1375	8,478	10,428,186	459	18.48	5.6	1,184
1381.8	11,868	14,597,640	525	22.61	6.9	1,355
1382	12,025	14,790,996	526	22.85	7.0	1,358
Canyon Lake spills at greater than 1382.1'						
Moderate year as in 1994						1,664
Wet year as in 1998						17,838
Average						**4,083**

* Typical Canyon Lake elevations under wet conditions is 1382' or greater. Under moderate conditions, the lake elevation ranges from 1375 to 1382'; under dry conditions, lake elevation is below 1375'.

A point should be made with regard to differences between the assumptions made for Canyon Lake versus Lake Elsinore. First, staff assumed that there would be no reduction in the internal phosphorus sediment load for Canyon Lake. At this time, the effect of lake management practices (aeration, dredging, and/or possible alum addition) on phosphorus release rates in Canyon Lake has not been determined. Literature reviews indicate that phosphorus release from sediment is controlled by several factors, including water column sulfate concentration (Caraco *et al.*, 1989), redox potential, mixing intensity, temperature, bioturbation and sediment types (Holdren and Armstrong, 1980). Therefore, until additional studies are conducted, no reduction in the internal load of phosphorus for Canyon Lake is assumed

Phosphorus Load Capacity for Canyon Lake Based on Proposed Final Target

As for Lake Elsinore, the total phosphorus TMDL (load capacity) needed to meet the proposed final numeric target of 0.05 mg/L for Canyon Lake was also calculated. Results of this analysis are shown in Table 6-4 and Figure 6-3. The phosphorus load capacity increases significantly in a wet year (1998), while during the moderate year (1994), the total phosphorus load capacity only slightly increases as compared to the dry years (see Table 6-4 and Figure 6-3).

Table 6-4. Total external phosphorus TMDL for Canyon Lake to achieve the proposed final target of 0.05 mg/L

Elevation* (feet asl)	Volume (AF)	Volume (m^3)	Area (acres)	Mean Depth (feet)	Mean Depth (m)	TP TMDL (kg/yr)
1372	7,152	8,796,960	426	16.79	5.1	550
1375	8,478	10,428,186	459	18.48	5.6	592
1381.8	11,868	14,597,640	525	22.61	6.9	678
1382	12,025	14,790,996	526	22.85	7.0	679
Canyon Lake spills at greater than 1382'						
Moderate year as in 1994						897
Wet year as in 1998						8,919
Average						**2,053**

* Typical Canyon Lake elevation under wet conditions is at 1382' or greater. Under moderate conditions, the lake elevation ranges from 1375 to 1382'; under dry conditions, lake elevation is below 1375'.

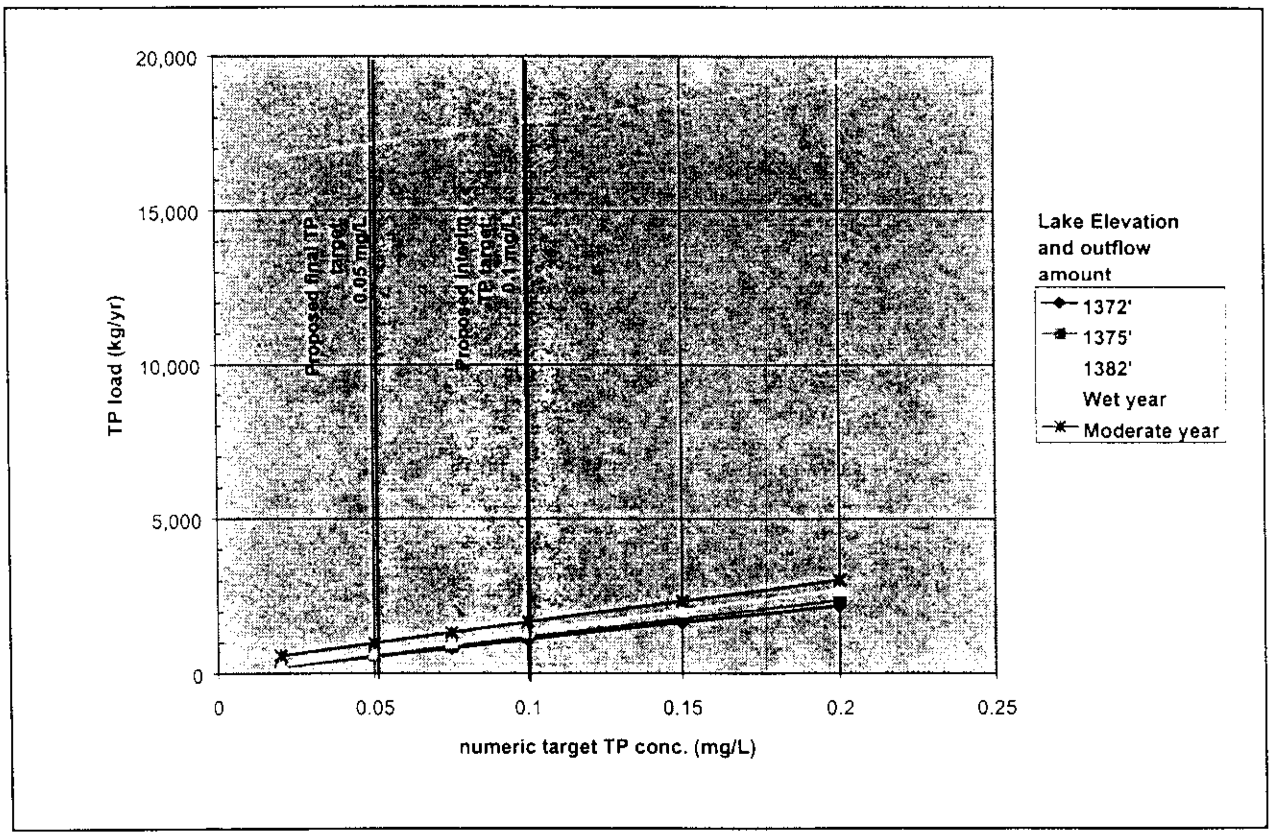


Figure 6-3. Total external phosphorus load capacity of Canyon Lake under different in-lake total phosphorus concentrations and different lake elevations and outflow amounts

6.3 Nitrogen TMDL (Load Capacity) for Lake Elsinore and Canyon Lake

Nitrogen load capacity for both lakes for the three hydrological conditions was calculated by multiplying the proposed numeric target for both lakes by the flow into the lakes.

$$\textbf{TN TMDL} = \mathbf{Q_{in}} * \textbf{numeric target}$$

For Lake Elsinore, the total inflow volume was determined by adding the local runoff volume to the overflow volume from Canyon Lake. Estimated annual runoff volumes from the local watershed surrounding Lake Elsinore were 945 AFY in 1994, 8,502 AFY in 1998, and 3,155 AFY in 2000 (Tetra Tech Inc., 2003). The overflows from Canyon Lake were 2641 AFY for 1994, and 133,981 AFY for 1998. For Canyon Lake, the inflow volume was calculated from the lake elevation data and the stage curve during dry years when the lake did not overflow. During wet and moderate years when Canyon Lake overflowed, the total inflow was assumed to equal the sum of the volume increase based on the elevation change before Canyon Lake spills that overflow volume.

The total nitrogen TMDLs for Lake Elsinore and Canyon Lake to achieve the interim target of 1.0 mg/L total nitrogen and the final target of 0.5 mg/L are listed in Tables 6-3 and 6-4, respectively. Again, these tables list average total nitrogen loading capacity to address the cumulative impacts of nutrient loads, irrespective of hydrologic condition.

Table 6-5. Lake Elsinore and Canyon Lake External Total Nitrogen TMDL (load capacity) for proposed interim target of 1.0 mg/L

Lake Elsinore					
	Flow Acre-ft/yr	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	142,483	175,254,090	1	0.001	175,254
Moderate	3,586	4,410,780	1	0.001	4,411
Dry	315	387,450	1	0.001	387
Average					**60,017**
Canyon Lake					
	Flow Acre-ft/yr	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	139,345	171,394,350	1	0.001	171,394
Moderate	5,812	7,148,760	1	0.001	7,149
Dry	3,578	4,400,940	1	0.001	4,401
Average					**60,981**

Table 6-6. Lake Elsinore and Canyon Lake External Total Nitrogen TMDL (load capacity) for proposed final target of 0.5 mg/L

Lake Elsinore					
	Flow (Acre-ft/yr)	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	142,483	1.75E+08	0.5	0.0005	87,627
Moderate	3,586	4410780	0.5	0.0005	2,205
Dry	315	387450	0.5	0.0005	194
Average					**30,009**
Canyon Lake					
	Flow Acre-ft/yr	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	139,345	1.71E+08	0.5	0.0005	85,697
Moderate	5,812	7,148,760	0.5	0.0005	3,574
Dry	3,578	4,400,940	0.5	0.0005	2,200
Average					**30,491**

6.4 Proposed TMDLs

Tables 6-7 and 6-8 summarize the proposed phosphorus and nitrogen TMDL for both Lake Elsinore and Canyon Lake to achieve the interim and final numeric targets. Included are the proposed allowable load from all external sources and the allowable load from internal sediments. The asterisked notation in Table 6-7 warrants specific mention. Comparison of the average external nitrogen load capacity (allowable average external nitrogen load) to meet the interim nitrogen target in Canyon Lake (60,981 kg/yr (Table 6-5)) to the average existing external nitrogen load (53,131 kg/yr (Table 5-11)) shows that the average existing external load is less than the load capacity. Given the cumulative effects of nutrient loads, it is not sensible to allow higher than existing loads. Therefore, in the case noted, the average existing external load was used as the basis for the external load TMDL, rather than the calculated load capacity.

The next section will discuss how these loads are allocated amongst all sources.

Table 6-7. Nutrient TMDL to achieve the interim targets of phosphorus (0.1 mg/L) and nitrogen (1 mg/L) for Canyon Lake and Lake Elsinore (to be met as soon as possible, but no later than 2009) (all numbers in kg/yr)

	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	21,554[+]	4,625	197,370	13,549
External Loading	9,951	4,083	60,017	53,132*
Total TMDL	31,505	8,708	257,387	66,680

* The calculated external nitrogen load capacity turned out to be greater than the model-simulated existing nitrogen load. To allow more load than the existing load doesn't make sense. Therefore, the simulated existing load is used for TMDL allocation.

+ Assumes 35% reduction in internal phosphorus loading

Table 6-8. Nutrient TMDL to achieve the interim targets of phosphorus (0.05 mg/L) and nitrogen (0.5 mg/L) for Canyon Lake and Lake Elsinore (to be met as soon as possible, but no later than 2019) (all numbers in kg/yr)

	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	9,948+	4,625	197,370	13,549
External Loading	2,895	2,053	30,009	30,491
Total TMDL	12,843	6,678	227,379	44,040

+ Assumes 70% reduction in internal phosphorus loading

7.0 Proposed Lake Elsinore and Canyon Lake Total Phosphorus and Total Nitrogen Waste Load Allocations and Load Allocations

As discussed in Section 5, nutrient sources to Canyon Lake and Lake Elsinore come from both point source and nonpoint source discharges. In order to derive the proposed waste load allocations (WLAs) for point source discharges and load allocations (LAs) for nonpoint source discharges, staff utilized the model results from Tetra-Tech and in-lake sediment release studies from Anderson to determine current nitrogen and phosphorus loading. Staff then determined the reductions required from all sources in order to meet the proposed TMDLs.

The TMDL, WLA and LA take into consideration the cumulative effect of the watershed hydrological conditions. The approach employed allocates the phosphorus and nitrogen TMDL calculated in Section 6 (Tables 6-7 and 6-8), based on average external load capacity, to the sources to facilitate implementation. In addition, the TMDL allocation applies to a 5-yr running average, meaning that phosphorus and nitrogen loads from each source will be continuously monitored for 5 years, and the average of the load over the five years shall not exceed the TMDL allocation. This approach takes in account the cumulative effect of nutrient loads from year to year[9].

Point sources discharges of nutrients to Canyon Lake and Lake Elsinore include urban storm and non-stormwater runoff (MS4) and discharges from confined animal feeding operations (CAFOs). Recycled water discharges to Lake Elsinore by Eastern Municipal Water District (EMWD) and/or Elsinore Valley Municipal Water District (EVMWD), which are intended to maintain the lake level, are an additional point source of nutrients. While not now regulated as a point source discharge, Colorado River Water is used to supplement and maintain the lake level in Canyon Lake.

Nonpoint source discharges of nutrients considered in the Tetra Tech simulations include those from on-site disposal systems (septic systems), agricultural runoff, atmospheric deposition, open space/forest runoff and internal loading from lake sediments.

Proposed WLAs and LAs to achieve the interim and final phosphorus and nitrogen targets for all nutrient sources for Lake Elsinore and Canyon Lake are shown in Tables 7-1, and 7-2, respectively. The following discussion describes the approach used to determine the LA and WLA for each of these nutrient sources.

[9] In developing this TMDL, the wasteload and load allocations for each source were initially calculated based on the allowable loads under wet, moderate and dry conditions (represented by lake elevation and volume (Tables 6-1 through 6-6), rather than the average loads. In other words, three sets of wasteload and load allocations were identified, each pertaining to one of the hydrologic conditions. These are presented in Appendix A. In some cases, particularly under the wet scenario, the calculated allowable allocations for the sources were higher than existing loads. This correlates with the finding, described in Section 6, that the load capacity of the lakes is higher under wet conditions, due to increased lake elevation and volume. However, a TMDL approach that would allow higher than existing loads under any condition makes no sense and fails to take into account the cumulative effect of nutrient loads to the lakes (see discussion at end of Section 5). In additional, having separate TMDL allocations for different hydrologic conditions makes implementation difficult. It requires the accurate prediction of hydrologic condition in any given year. Such prediction is not feasible at the present time. Therefore, a revised approach utilizing average allowable loads is recommended as the basis for determining wasteload and load allocations.

Lake Elsinore Supplemental Water

The average amount of supplemental water needed to maintain Lake Elsinore levels at 1240 to 1247 feet (considered the appropriate operation range)[10] is 8,800 AFY. Under worst-case drought conditions, up to 13,800 AFY of supplemental water may be needed to maintain the lake elevation above 1240 feet (CH2M Hill, 2003). Of these amounts, 5000 AFY is assumed to come from the groundwater via three island wells, while the rest would come from recycled wastewater from either EMWD or EVMWD (CH2M Hill, 2002). Nitrogen and phosphorus concentrations in well water are below detection limit (0.02 mg/L for TP and 0.1 mg/L for TN), therefore, no nutrient load is allocated to well water.

Currently, the total phosphorus concentration of recycled water from the EVMWD Treatment Plant averages 2.12 mg/L, while the total phosphorus concentration of EMWD recycled water averages 0.28 mg/L[11]. The average total nitrogen concentration of the recycled water from the EVMWD Treatment Plant and the EMWD recycled water are 7.16 mg/L and 8.1 mg/L, respectively (Anderson and Nascimento, 2003). The difference in the SRP quality between EVMWD and EMWD is due to the fact that EMWD's new treatment plants are designed to reduce phosphorus concentrations to 0.5 mg/L (Montgomery Watson, 2000). Staff believes that it is reasonable and feasible to assume that all recycled water discharged to the lake will have a phosphorus concentration of 0.5 mg/L, or less[12]. To determine the allocations necessary to achieve the interim targets, it is assumed that recycled water quality will be limited to 0.5 mg/L TP and 1mg/L total nitrogen. Using a total volume of recycled water of 3,300 acre-feet, the total phosphorus and total nitrogen waste load allocation to meet the interim target are calculated to be 2,030 kg/yr and 4,059 kg/yr, respectively. Under the worst case drought condition when 8,800 acre-feet/yr recycled water may be needed for Lake Elsinore, the waste load allocations for phosphorus and nitrogen would be 5,412 kg/yr and 10,824 kg/yr, respectively, to meet the interim targets. Employing the average approach that staff recommends, the interim waste load allocations for phosphorus and nitrogen for the recycled water are 3,721 kg/yr and 7,242 kg/yr, respectively. However, the external phosphorus load capacity to meet the final phosphorus numeric target of 0.05 mg/L, is 2895 kg/yr and 30,009 kg/yr, respectively. A more stringent phosphorus WLA is necessary to meet the final phosphorus target of 0.05 mg/L. For the purposes of determining allocations to achieve the proposed final phosphorus target, it is assumed that the phosphorus concentration in the recycled water quality will be limited to 0.2 mg/L. As already noted, the recommended permit will likely include an offset provision.

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[10] This is the lake operation range proposed by the Lake Elsinore and San Jacinto Watershed Authority, which is different than the lake operation range proposed by the Lake Elsinore Management Authority (LEMA) in the 1990s.

[11] EMWD has several treatment plants in the San Jacinto Watershed. The 0.28 mg/L SRP concentration is an average concentration of phosphorus discharged to Lake Elsinore in 2003.

[12] It is anticipated that the discharge permits for EMWD/EVMWD would specify compliance with a numeric limit for phosphorus of 0.5 mg/L or less, and that the permits would also allow the implementation of an offset program, should strict compliance with this numeric limitation be demonstrated to be infeasible. Implementation of an offset program in lieu of strict compliance with the numeric limit would require the discharger to assure removal from the lake of phosphorus discharged above the numeric limit on at least a one-to- one basis.

Canyon Lake Supplemental Water

On occasion, EVMWD purchases Colorado River water from the Metropolitan Water District to ensure that Canyon Lake levels are maintained at 1372 feet. Colorado River water has very low nitrogen and phosphorus concentrations (0.2 mg/L and non-detect, respectively) (EVMWD, personal communication, 2001). The most recent addition of supplemental water to Canyon Lake occurred in April 2002 (1,006 AF was added). With the nitrate-nitrogen and total phosphorus concentrations shown above, the total nitrogen WLA for Canyon Lake supplemental water is 247 kg/yr and the total phosphorus WLA is zero.

Atmospheric Deposition

The proposed load allocation for atmospheric deposition is the same as the estimated existing load discussed in Section 5 (Canyon Lake: TN = 1,918 kg/yr, TP = 221 kg/yr; Lake Elsinore: TN = 11,702 kg/yr, TP = 108 kg/yr). Overall, atmospheric deposition constitutes a small portion of the total nutrient loads to both lakes. Staff believes that reduction of this load is not feasible, and furthermore, would make little relative difference in attaining the proposed TMDL.

Internal Sources

To determine the internal loading allocation for Lake Elsinore, staff assumed that Lake aeration is in place to reduce the internal phosphorus sediment load by 35% in order to meet the proposed interim total phosphorus TMDL and interim numeric target of 0.1 mg/L (see discussion in Section 6). A 70% reduction in internal phosphorus loading rate is assumed in order to meet the final numeric phosphorus target of 0.05 mg/L. Aeration appears to have no effect on the release of nitrogen from sediments (Anderson, 2000). Therefore, no reduction in the internal nitrogen load to Lake Elsinore is assumed or proposed for the purposes of the load allocation.

For Canyon Lake, because no studies have been conducted on the efficiency of treatment methods, and because there are no plans to build and/or treat the internal nutrient sources, staff does not propose a reduction in the sediment phosphorus or nitrogen loads to Canyon Lake. As shown in Table 7-1, the existing internal nutrient release rates for nitrogen and phosphorus in Canyon Lake are allocated as the proposed interim and final LAs, (4,625 kg/yr of phosphorus and 13,549 kg/yr of nitrogen).

Urban Storm and Non-stormwater Runoff, Confined Animal Feeding Operations, Agriculture, Open/Forest, and Septic Systems

The remaining existing or potential nutrient sources, urban runoff, CAFOs, agriculture, open space/forest runoff, and septic systems, originate from the various land use practices in the watershed. To determine the WLAs for urban and CAFO nutrient discharges and the LAs for agriculture, open space/forested lands and septic systems, staff calculated the allowable load from these sources, taking into consideration the assumed WLA for supplemental water and the LAs for internal sediment sources and atmospheric deposition as follows:

$$\mathbf{TMDL = \Sigma WLA + \Sigma LA + MOS}$$

where:

ΣWLA = supplemental water WLA + CAFO WLA + Urban (MS4) WLA
ΣLA = agriculture LA + septics LA + open/forest LA + internal sediment LA
MOS = margin of safety was incorporated via conservative assumptions, therefore no explicit MOS is specified (see Section 8.0)

Proposed WLAs for supplemental water and the proposed LAs for atmospheric deposition and internal sediment load are discussed above. The allocations for the remaining land use based sources are all considered together as follows:

MS4 WLA + CAFO WLA + Ag LA + open LA + septic LA =TMDL – supple. water WLA – atmos LA – internal loading

To determine the nitrogen and phosphorus allocations for each of the land use- based sources (the left side of the above equation), the respective percentage of the average nutrient load for each source was used (Table 5-11). Even though the EFDC predicted a significant nutrient contribution from Canyon Lake to Lake Elsinore, Canyon Lake was not given a load allocation because the nutrients from Canyon Lake were originally from the watershed and therefore those loads will be allocated to the sources in the San Jacinto River watershed.

Table 7-1 lists the proposed waste load allocations for point sources, load allocations for nonpoint sources and the comparison to the existing loads estimated from the LSPC model, as well as the percentage load reduction required in order to meet the proposed interim nutrient targets.

The same approach is used to determine the phosphorus and nitrogen WLAs and LAs for all potential sources to achieve the proposed final numeric targets. Table 7-2 lists the nitrogen and phosphorus waste load allocations, load allocations, in comparison to the average existing loads estimated from the LSPC model, and the percentage load reduction required in order to meet the proposed final nutrient targets.

The TMDL allocations proposed in Tables 7-1 and 7-2 apply to a 5-year running average, meaning that the average loads from each source over the 5-year period shall not exceed the allocations specified in the Tables. Proposed allocations to meet the interim targets (Table 7-1), are to be achieved as soon as possible, but no later than 2009. Likewise, the proposed allocations to meet the final targets (Table 7-2) are to be achieved as soon as possible, but no later than 2019. This approach takes into account the cumulative impact of nutrients on lake water quality, and overcomes the limitation of the model used to calculate the nutrient load capacity of the lakes which was stated in Section 6. This approach also provides sufficient time for the stakeholders in the watershed to plan and implement nutrient control measures to meet the TMDL proposed to achieve targets. In addition, it allows Regional Board staff and the stakeholders to continue monitoring of the watershed and lakes and to refine the TMDL if, and as necessary.

Table 7-1 Proposed Interim TMDL, Wasteload and Load Allocations for Lake Elsinore and Canyon Lake (to be achieved as soon as possible, but no later than 2009)

Lake Elsinore

	Nitrogen Load Allocation (kg/yr)[b]	Existing TN Load (kg/yr)[a]	Reduction (%)	Phosphorus Load Allocation (kg/yr)[b]	Existing TP Load (kg/yr)[a]	Reduction (%)
TMDL	**257,387**	**419,090**	39	**31,505**	**82,422**	62
WLA	18,072	73,012		4,739	17,446	
Supplemental water*	7,442	59,532	87	3,721	14883	75
Urban	6,692	8,486	21	635	1599	60
CAFO	3,938	4,994	21	383	964	60
LA	239,315	346,078	31	26,766	64,976	
Internal Sediment Source	197,370	197,370	0	21,554	33,160	35
Atmospheric Deposition[c]	11,702	11,702	0	108	108	0
Agriculture	14,094	17,873	21	2,966	7473	60
Open/Forest	5,630	7,141	21	1,733	4366	60
Septics	10,519	13,341	21	405	1021	60
Export from Canyon Lake**	0	98,651			18848	
MOS***	0			0		

Canyon Lake

	Nitrogen load Allocation (kg/yr)	Existing TN load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing TP Load (kg/yr)	Reduction (%)
TMDL	**66,680**	**66,680**	**0**	**8,708**	**20,649**	58
WLA	13,807	13,807		660	2,699	
Supplemental water+	248	248	0	0	0	
Urban	8,391	8,391	0	419	1713	76
CAFO	5,168	5,168	0	241	986	76
LA	52,873	52,873	0	8,049	17,950	
Internal Sediment Source	13,549	13,549	0	4,625	4,625	0
Atmospheric Deposition[c]	1,918	1,918	0	221	221	0
Agriculture	18,567	18,567	0	1,946	7962	76
Open/Forest	6,477	6,477	0	1,025	4193	76
Septics	12,362	12,362	0	232	949	76
MOS***						

* The WLA allocation for supplemental water to Lake Elsinore only considered the recycled water.
** The source "Export from Canyon Lake" was not given any load allocation. Instead, the load was given to the sources in the watershed.
*** Implicit Margin of safety is considered due to the conservative approach in numeric target selection (see Section 8 for further discussion).
[+] The WLA for supplemental water to Canyon Lake was calculated based on the recent addition of the Colorado River water to Canyon Lake.
[a] See Table 5-11
[b] See Table 6-7
[c] The atmospheric deposition loads were derived from literature value and local precipitation data.

Table 7-2 Proposed Final TMDL, Wasteload and Load Allocations for Lake Elsinore and Canyon Lake (to be achieved as soon as possible, but no later than 2019)

Lake Elsinore

	Nitrogen load Allocation (kg/yr)[b]	Existing TN load (kg/yr)[a]	Reduction (%)	Phosphorus Load Allocation (kg/yr)[b]	Existing TP Load (kg/yr)[a]	Reduction (%)
TMDL	**227,379**	**419,090**	46	**12,843**	**82,422**	84
WLA	10,268	73,012		1,704	17,446	
Supplemental water*	7,442	59,532	87	1,488	14883	90
Urban	1,779	8,486	79	135	1599	92
CAFO	1,047	4,994	79	81	964	92
LA	217,111	346,078		11,139	64,976	
Internal Sediment Source	197,370	197,370	0	9,948	33,160	70
Atmospheric Deposition[c]	11,702	11,702	0	108	108	0
Agriculture	3,746	17,873	79	629	7473	92
Open/Forest	1,497	7,141	79	368	4366	92
Septics	2,796	13,341	79	86	1021	92
Export from Canyon Lake**	0	98,651			18848	0
MOS* **	0			0		

Canyon Lake

	Nitrogen load Allocation (kg/yr)	Existing TN load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing TP Load (kg/yr)	Reduction (%)
TMDL	**44,041**	**66,680**	34	**6,678**	**20,649**	68
WLA	7,784	13,807		313	2,699	
Supplemental water[+]	248	248	0	0	0	
Urban	4,664	8,391	44	199	1713	88
CAFO	2,872	5,168	44	114	986	88
LA	36,257	52,873		6,365	17,950	
Internal Sediment Source	13,549	13,549	0	4,625	4,625	0
Atmospheric Deposition[c]	1,918	1,918	0	221	221	0
Agriculture	10,319	18,567	44	923	7962	88
Open/Forest	3,600	6,477	44	486	4193	88
Septics	6,871	12,362	44	110	949	88
MOS	0			0		

* The WLA allocation for supplemental water to Lake Elsinore only considered the recycled water.
** The source "Export from Canyon Lake" was not given any load allocation. Instead, the load was given to the sources in the watershed.
*** Implicit Margin of safety is considered due to the conservative approach in numeric target selection (see Section 8 for further discussion).
[+] The WLA for supplemental water to Canyon Lake was calculated based on the recent addition of the Colorado River water to Canyon Lake.
[a] See Table 5-11
[b] See Table 6-7
[c] The atmospheric deposition loads were derived from literature value and local precipitation data.

8. Margin of Safety, Seasonal Variations, and Critical Conditions

8.1 Margin of Safety

TMDLs must include an explicit or implicit margin of safety (MOS) to account for uncertainty in determining the relationship between pollutant loads and impacts on water quality. An explicit MOS can be provided by reserving (not allocating) part of the TMDL and therefore requiring greater load reductions from existing and/or future sources. An implicit MOS can be provided by conservative assumptions in the TMDL analysis.

Sources of uncertainty in the Lake Elsinore/Canyon Lake nutrient TMDL development analysis include: 1) the lack of watershed specific data on phosphorus and nitrogen loading from surface runoff; 2) the inherent seasonal and annual variability in delivery of phosphorus and nitrogen from external sources and nutrient cycling within Lake Elsinore and Canyon Lake;
3) assumptions made about the rate of nutrient release from the sediment and the efficiency of lake treatment technologies; and, 4) the lack of established relationships between external and internal nitrogen loads and in-lake nitrogen concentration. In addition, the water quality model developed to link the in-lake phosphorus concentration and internal load and external load suggests that the error range of phosphorus concentration depends on the error range of internal loading rate, net sedimentation rate and external load. The error range for the Lake Elsinore sedimentation rate was determined using historical data, however, because of the lack of data, determination of the error range for Canyon Lake internal loading rate and external load was not feasible.

Because of these uncertainties, staff selected the numeric target value conservatively (by using the 25th percentile of the nutrient concentration during the reference year). Staff also made conservative assumptions when developing the load allocations, (*e.g.*, assuming a constant value for atmospheric deposition and internal loading). The phosphorus model parameters used to calculate the phosphorus load capacity were based on the study during dry conditions. In addition, the LSPC model used to simulate the load to lake used conservative literature values as well (*e.g.*, assumptions used to simulate the nutrient runoff from the septic systems). All these approaches therefore address the MOS implicitly. As new data are collected under various hydrologic conditions, data gaps will be filled, a more robust uncertainty analysis can be conducted and the MOS and TMDL can be adjusted as appropriate.

8.2 Seasonal Variations and Critical Conditions

TMDLs must include consideration of seasonal factors and critical conditions. The US EPA's protocol for developing nutrient TMDLs (1999) defines "critical conditions" as "the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence."

All aquatic ecosystems, whether or not being affected by human activities, show seasonal and annual variations in the rates of nutrient input and internal cycling. Nutrient concentrations may be more important at certain times of the year. For example, in north temperate lakes, spring increases in water temperature and available solar radiation for photosynthesis can trigger spring algal blooms if adequate amounts of nutrients are present. The nutrients may be available in the winter, but low temperatures and short, cloudy days will inhibit blooms. Other symptoms of eutrophication such as dissolved oxygen depletion also vary seasonally or annually; impacts on recreation, aquatic life and water supply beneficial uses are generally the most severe during the period of summer thermal stratification and highest plant productivity. Algal blooms also occur when lakes turn over and the nutrients from the hypolimnion are brought to the photic zones.

In Lake Elsinore and Canyon Lake, external phosphorus and nitrogen loading occurs mostly in the winter and spring, due to California's wet winter/dry summer climate. Soluble phosphorus and nitrogen released from lake sediments is greatest during the summer, due to high temperature and low dissolved oxygen (Anderson, 2001). The aerobic release of phosphorus P and nitrogen from littoral sediment occurs during the warmer part of the year (Anderson and Oza, 2003). Although fishing and other recreational uses occur year-round at Lake Elsinore and Canyon Lake, the potential impact of eutrophication on recreational uses is also greatest in summer.

The nutrient TMDL for Lake Elsinore and Canyon Lake accounts for seasonal and annual variations in external and internal phosphorus loading, and associated impacts on beneficial uses, in several ways:

1) The assessment of nutrient sources to the lake specifically accounts for variations in hydrologic conditions (wet, moderate and dry) and the transport of nutrients to and from the lakes under these conditions. Similarly, the determination of load capacity accounts for variation based on hydrologic condition. While these seasonal differences are clearly recognized, an average approach is recommended to address cumulative impacts of nutrient loads, and to facilitate TMDL implementation.
2) The most critical condition for attainment of aquatic life and recreational uses in Lake Elsinore and Canyon Lake occurs during the summer, when the greatest release of phosphorus and nitrogen from the sediment occurs and warm temperatures promote algal growth resulting in the depletion of oxygen. The source analysis demonstrates that during the summertime, the predominant source of nutrients resulting in eutrophication is the internal loading from sediments. The proposed TMDL address this critical condition by requiring that the sediment phosphorus loading be reduced by 35% to meet the proposed interim target, and by 70% to meet the proposed final target.
3) As discussed in Section 6.4, in one instance, the calculated nitrogen load capacity for Canyon Lake exceeded the average existing load. In this case, the average existing load, rather than the load capacity, was used for allocation purposes.

9. Implementation Recommendations

Federal regulations require the State to identify measures needed to implement TMDLs in the state water quality management plan (Basin Plan) (40 CFR 130.6). California law requires that Basin Plans have a program of implementation to achieve water quality objectives. The implementation program must include a description of actions necessary to achieve the objectives, a time schedule for these actions, and a description of surveillance to determine compliance with the objectives. Staff proposes that the Lake Elsinore and Canyon Lake Nutrient TMDL be adopted as a Phased TMDL. The TMDL's phased implementation framework provides time to conduct further monitoring and assessment, including the development of needed in-lake dynamic models (see below) and refinement of the existing watershed model. The results of these studies may provide the analytical basis for modifying the TMDL, WLAs, LAs and/or other elements of the TMDL.

The proposed Basin Plan amendment, shown in Attachment A, includes an implementation plan and monitoring program designed to implement the TMDL and evaluate its effectiveness. Implementation is expected to result in compliance with the proposed nutrient TMDL and allocations for Canyon Lake and Lake Elsinore and thereby ensure protection of the beneficial uses of these waterbodies. The proposed implementation plan includes requirements directed at both point and nonpoint sources.

<u>Implementation Actions by Regional Board</u>

In order to implement the TMDL, WLAs and LAs, Board staff proposes that the Regional Board undertake the following actions. Proposed dates for implementation of these actions are specified in the proposed Basin Plan amendment (Attachment A).

- Establish New Waste Discharge Requirements
  The Regional Board shall issue a new NPDES permit to Elsinore Valley Municipal Water District for supplemental water discharges to Canyon Lake that incorporates the appropriate WLAs, compliance schedule and monitoring program requirements.

- Revise Existing Waste Discharge Requirements
  The Regional Board shall review and revise, as necessary, the following existing NPDES permits to incorporate the appropriate WLAs, compliance schedules and monitoring program requirements.

  - Waste Discharge Requirements for the Riverside County Flood Control and Water Conservation District, the County of Riverside and the Incorporated Cities of Riverside County within the Santa Ana Region, Areawide Urban Runoff, NPDES No. CAS 618033 (Regional Board Order No. R8-2002-0011)

  - General Waste Discharge Requirements for Concentrated Animal Feeding Operations (Dairies and Related Facilities) within the Santa Ana Region, NPDES No. CAG018001 (Regional Board Order No. 99-11).

- Waste Discharge and Producer/User Reclamation Requirements for the Elsinore Valley Municipal Water District, Regional Water Reclamation Facility Riverside County, Order No. 00-1, NPDES No. CA8000027.

- Waste Discharge Requirements for Eastern Municipal Water District, Regional Water Reclamation System, Riverside County, Order No. 99-5, NPDES No. CA8000188.

- Watershed-Wide Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with New Developments in the San Jacinto Watershed, Order No. 01-34, NPDES No. CAG 618005.

- Review/Revise Water Quality Objectives in the Basin Plan to establish site specific nutrient criteria for Lake Elsinore and Canyon Lake.
  The Regional Board intends to consider revision/adoption of nutrient water quality objectives for both lakes. Given the budgetary constraints, this effort is likely to require substantive resource contributions from interested parties.

Actions Recommended for Implementation by Other Agencies/Entities

In order to ensure that effective nutrient control programs that achieve the appropriate interim and final WLAs and LAs are developed and implemented, staff proposes that the following requirements for the appropriate responsible entity be incorporated into the Implementation Plan. Proposed dates for implementation of these actions are specified in the proposed Basin Plan amendment (Attachment A).

- Development and implementation of a Nutrient Management Plan by agriculture operators;

- Public education, septic system maintenance and septic system maintenance enforcement is the responsibility of Riverside County Health Department and certain municipalities with their own oversight and permitting program. Staff proposes that the Basin Plan amendment specify a requirement for the Riverside County Health Department to develop and implement a Septic System Management Plan. The development and implementation of this plan would be coordinated with any new requirements established pursuant to AB 885[13].

- Revision to, and implementation of, the County of Riverside Drainage Area Management Plan (DAMP) by the Riverside County Flood Control and Water Conservation District and co-permittees in the San Jacinto River watershed to describe the measures to comply

[13] AB 885 amended the California Water Code to add Section 13290 – 13290.7 to require the State Board, in conjunction with the State Department of Health Services, the California Coastal Commission and county and/or city environmental health agencies to adopt regulations for the permitting, maintenance, monitoring and oversight of on-site disposal systems. The State Board is currently in the process of working with various stakeholders to develop the appropriate regulations.

with this TMDL. Provisions specified in the Areawide stormwater permit may suffice to address TMDL requirements (provisions of the DAMP and the water quality management plan (WQMP)).

- Revision to, and implementation of, the San Bernardino National Forest and the Cleveland National Forest Management Plans to address nutrient discharges.

- Agricultural operators, Confined Animal Feeding Operation operators, the Riverside County Flood Control and Water Conservation District and co-permittees, the Riverside County Health Department and the US Forest Service, shall develop and implement a plan to address the in-lake nutrient loads in Lake Elsinore.

- Agricultural operators, Confined Animal Feeding Operation operators, the Riverside County Flood Control and Water Conservation District and co-permittees, the Riverside County Health Department and the US Forest Service, shall evaluate in-lake treatment options to control internal nutrient loading in Canyon Lake. These options should include but are not limited to, alum treatment, aeration/oxygenation, dredging, biomanipulation, and others.

Implementation Schedule

Regional Board staff proposes that the interim targets for both Canyon Lake and Lake Elsinore (see Section 4, Tables 4-1 and 4-3) and the allocations specified in Table 7-1 be met as soon as possible but no later than 2009. Staff recommends that the final targets (Tables 4-1 and 4-3) and allocations (Table 7-2) be met as soon as possible but no later than 2019.

10. Monitoring Program Recommendations

Section 13242 of the California Water Code specifies that Basin Plan implementation plans must contain a description of the monitoring and surveillance programs to be undertaken to determine compliance with water quality objectives. As part of the incorporation of the proposed Canyon Lake and Lake Elsinore Nutrient MDL into the Basin Plan, several monitoring requirements are proposed (Attachment A) in order to evaluate the effectiveness of actions and programs implemented pursuant to the TMDL. Since the Canyon Lake and Lake Elsinore Nutrient TMDL is a phased TMDL, follow-up monitoring and evaluation is essential to validate and revise the TMDL as necessary.

A. Watershed-wide Nutrient Water Quality Monitoring Program

A watershed-wide nutrient monitoring program was implemented in 2000 by Regional Board staff and stakeholders in the watershed. The purpose of this monitoring program has been to collect data needed to develop the nutrient TMDLs. The monitoring program consists of the collection of stream flow and water quality data in the San Jacinto River watershed, with a focus on collecting nutrient data from specific nutrient sources (e.g., septic systems, open space/forest lands, urban runoff, and CAFOs).

Staff believes that continuation of this watershed-wide monitoring program will be essential to track the effectiveness of the TMDL implementation plan and to track the effectiveness of source load reductions. Staff recommends that the Basin Plan amendment specify that all watershed dischargers continue to implement this watershed-wide nutrient monitoring program. All of the stream gauging stations built and operated as part of the watershed-wide monitoring program should also be operated and maintained on a continuing basis, and water quality samples should be collected from all stations at the same frequency to quantify nutrient loads from various sources in the watershed. The data generated will not only be used to evaluate TMDL compliance, but will also be used calibrate the watershed model developed for the watershed by Tetra-Tech, Inc.

B. Canyon Lake and Lake Elsinore In-lake Monitoring Programs

Regional Board staff and watershed stakeholders implemented a Canyon Lake and Lake Elsinore in-lake monitoring program in 2000. This program, which is on-going, consists of collection of water quality data at stations in both Canyon Lake and Lake Elsinore on a year-around basis. The purpose of this program is to allow evaluation of changes in lake water quality due to nutrient input or other environmental factors.

Staff proposes in the Basin Plan amendment that watershed stakeholders continue the in-lake monitoring programs to assess the response of the lakes to nutrient loadings and to determine if the load reductions result in the achievement of numeric targets (as proposed in Section 4).

C. Pollutant Source Monitoring

Monitoring of pollutant sources is needed to ensure that required reductions are being achieved to meet the WLAs, LAs and TMDL. As part of Phase II of the TMDL, these data will be used to refine the specified allocations, as appropriate. Specific monitoring program requirements for the following sources are proposed in the Basin Plan amendment.

- CAFOs
- Urban discharges
- Supplemental water discharges to Lake Elsinore
- Supplemental water discharges to Canyon Lake
- Agricultural discharges
- Septic system discharges

In addition, for some nutrient sources, specific data are needed to refine the watershed model or to develop specific BMPs. These needs, listed below, are also addressed in the proposed Basin Plan amendment.

- Agricultural dischargers: Studies need to be conducted to inventory crops grown in the watershed, the amount of manure and/or fertilizer applied to each crop and amount of nutrients released from the croplands. Evaluation of site-specific BMPs is also needed to determine their effectiveness and to determine compliance with the proposed LA.

- Septic systems: Currently, there are not a lot of data with regard to septic systems in the Canyon Lake/Elsinore watershed. When the source analysis was conducted, Tetra-Tech, Inc. had to make assumptions based on literature values with regard to loading of nutrients from septic systems. Staff believe it is necessary to conduct studies on the impact septic systems have on Canyon Lake and Lake Elsinore nutrient water quality, as well as to track implementation of the septic system LA.

D. Special studies

Finally, staff believes that there is a need to conduct special, nutrient-related studies in the watershed.

- In-lake treatment of sediment to remove nutrients: The applicability of various in-lake treatment technologies to prevent the release of nutrients from lake sediments should be evaluated in order to develop a long-term strategy for control of nutrients from the sediment. Examples of treatment technologies include aeration, alum treatment, wetland treatment, fishery management, and dredging. Based on studies conducted in Lake Elsinore, aeration and fishery management[14] projects have been selected as viable options for addressing the nutrient in-lake sediment load, and are currently in progress. These types of studies should also be done for Canyon Lake.

- Model update/development: Dynamic models for the simulation of nutrient dynamics in Canyon Lake and Lake Elsinore should be developed to allow for the modeling of the fate and transport of nutrients in the lakes. As discussed in Section 4, only simplified water quality models exist for both lakes. Development of dynamic models will enable Regional Board staff and lake managers to determine the effect external watershed nutrient sources, as well as in-lake sediment nutrient sources, have on the kinetics of nutrient cycling, algal uptake, composition and decay rates, dissolved oxygen levels and fishery composition. Furthermore, dynamic models will be useful for future refinements of the TMDLs, WLAs, LAs as well as numeric targets.

  Update of the watershed nutrient model developed by Tetra-Tech, Inc will also be needed in the future as additional data are generated. An updated watershed model could be used to determine BMP effectiveness and to determine TMDL, WLA and LA compliance. The model could also be used as a tool to evaluate potential pollutant trading options.

- Monitoring to determine the relationship between ammonia toxicity and total nitrogen allocation to ensure that the total nitrogen TMDL allocation will protect the lakes from ammonia toxicity.

[14] The Lake Elsinore fishery management plan under development includes removal of bottom dwelling fish- carp and shad, and introduction of stripped bass. Nutrient release rates will be reduced through fishery management because the bio-turbation from carp and shad that contributes to nutrient releases will be controlled.

11. Economic Considerations

As previously stated, the Regional Board is required to include TMDLs in the Basin Plan. There are three statutory triggers for consideration of economics in basin planning. These triggers are:

- Adoption of an agricultural water quality control program (Water Code Section 13141). The Regional Board must estimate costs and identify potential financing sources in the Basin Plan before implementing any agricultural water quality control plan.
- Adoption of a treatment requirement or performance standard. The Regional Board must comply with the California Environmental Quality Act (CEQA) when amending the Basin Plan. CEQA requires that the Board consider the environmental effects of reasonably foreseeable methods of compliance with Basin Plan amendments that establish performance standards or treatment requirements, such as TMDLs. The costs of the methods of compliance must be considered in this analysis.
- Adoption of water quality objectives (Water Code Section 13241). The Regional Board is required to consider a number of factors, including economics, when establishing or revising water quality objectives in the Basin Plan.

It should be noted that in each of these cases, there is no statutory requirement for a formal cost-benefit analysis.

As discussed above, adoption of a TMDL does not constitute the adoption of new or revised water quality objectives, so the third statutory trigger does not apply here. However, implementation of this TMDL is likely to result in changes in agricultural operations to control nutrient runoff. Similarly, implementation of this TMDL will likely necessitate changes in programs (including educational programs and BMPs) designed to reduce nutrient inputs from urban stormwater or other sources. It is necessary, therefore, to consider the costs and potential funding mechanisms for the implementation of new/modified agricultural water quality control programs, and the costs of other measures that may be necessary to achieve (and monitor) compliance with the TMDL.

Information concerning the costs of implementation of this TMDL will be solicited during the public participation phase of consideration of this TMDL. Specifically, potentially affected parties will be asked to evaluate the TMDL-related costs. The following list identifies possible sources of funding.

A. Grant Programs
   1. US EPA Clean Water Act 319(h) Program The Division of Water Quality, State Water Resources Control Board (SWRCB) administers water quality grants funded by the Federal Clean Water Ac (CWA) section 319 grant program. CWA section 319 funds may be used for implementation actions to prevent, control and/or abate nonpoint source (NPS) water pollution
      http://wwww.swrcb.ca.gov/nps/cwa_rfps.html

UC Cooperate Extension in Riverside County has applied for a Section 319 grant to assess and implement BMPs to reduce nutrient loads from croplands to Canyon Lake and Lake Elsinore. The proposal is under review by the State Board.

2. Proposition 13. In March 2000, California voters approved Proposition 13 (2000 Water Bond), which authorizes the State of California to sell $1.97 billion in general obligation bonds to support safe drinking, water quality, flood protection and water reliability projects throughout the state. The State Water Resources Control Board (SWRCB) will help allocate $763.9 million of these funds to local projects throughout California. A portion of the Proposition 13 funds, $15 million, has been set aside to support projects for Lake Elsinore restoration and San Jacinto River Watershed protection. A joint powers authority, the Lake Elsinore and San Jacinto Watershed Authority (LESJWA), comprised of the Cities of Lake Elsinore, Canyon Lake, Elsinore Valley Municipal Water District, County of Riverside and SAWPA, was formed to administer the funds. The projects under construction and consideration include: Lake Elsinore de-stratification; Lake Elsinore aeration; Lake Elsinore carp removal and fishery management; Canyon Lake de-stratification and aeration; Canyon Lake dredging; and nutrient removal from recycled water and Lake Elsinore water. All these projects should improve water quality in Lake Elsinore and Canyon Lake, if and when implemented. Regional Board staff are working closely with LESJWA board staff to ensure that the TMDL will be consistent with the objectives of the projects considered. SAWPA has also applied for a Proposition 13 grant to support the TMDL monitoring and to upgrade the watershed and lake modeling efforts. This proposal is also under review by the State Board.

3. State Board/Regional Board Funds- NPS Program funding sources: http://www.swrcb.ca.gov/nps/ofundsrc.html

B. Private financing (corporations or individuals)

C. Public financing (local agencies)
   1. State loan programs
   2. Local tax funds

12. California Environmental Quality Act (CEQA)

The Secretary of Resources has certified the Basin Planning process as functionally equivalent to the preparation of an Environmental Impact Report (EIR) or a Negative Declaration pursuant to the California Environmental Quality Act (CEQA). However, in lieu of these documents, the Regional Board is required to prepare the following: the Basin Plan amendment; an Environmental Checklist that identifies potentially significant adverse environmental impacts of the Basin Plan amendment; and, a staff report that describes the proposed amendment, reasonable alternatives, and mitigation measures to minimize any significant adverse environmental impacts identified in the Checklist. The Basin Plan amendment, Environmental Checklist, and staff report together are functionally equivalent to an EIR or Negative Declaration.

The draft Environmental Checklist (Attachment C to this report) concludes that there would be no potentially significant impacts on the environment caused by adoption of this Basin Plan amendment. Therefore, no mitigation measures are required.

This staff report will be followed by another report that includes comments received on the proposed amendment, staff responses to those comments, and a discussion of any changes made to the proposed amendment as the result of the comments or further deliberation by the Board, and/or Board staff. This follow-up report would address any additional CEQA considerations, including economics, that might arise as the result of any changes to the proposed amendment.

Consideration of Alternatives

1. No Project Alternative
   The "No Project" alternative would be no action by the Regional Board to adopt a TMDL with implementation measures and a monitoring program. This alternative would not meet the purpose of the proposed action, which is to correct ongoing violations of Basin Plan narrative objectives regarding algal growth and adverse impact to beneficial uses. This alternative would result in continuing water quality standards violations and threat to public health and safety, and the local economy. This alternative would not comply with the requirements of the Clean Water Act.

2. Alternatives
   The Regional Board could consider a TMDL based on alternative numeric targets, such as the literature values for mesotrophic/eutrophic classification. However, the proposed numeric targets are based on the best scientific information now available concerning the eutrophic status of Lake Elsinore and Canyon Lake and factors contributing to that status. The proposed targets provide the best assurance that the narrative water quality objective for algal growth will be achieved and that the beneficial uses will be protected. The proposed numeric targets are therefore consistent with the purpose of the TMDL.

   The Board could also consider an alternative TMDL implementation strategy that is based on a different compliance schedule approach. Adoption of a longer schedule would prolong non-attainment of the water quality standards. The proposed compliance schedule approach reflects the timing of implementation of projects proposed for Lake Elsinore and Canyon Lake by LESJWA, which are expected to result in improvement of Lake Elsinore and Canyon Lake. The proposed compliance schedule also considered the quality of available data for different hydrologic conditions and the needs for additional studies to fill data gaps and address uncertainties in TMDL calculation. The proposed compliance schedules are therefore, considered reasonable.

Finally, the Regional Board could consider an alternative TMDL approach that relies on wasteload and load allocations established for various hydrologic conditions. However, as discussed previously, such an approach would not account for cumulative nutrient loading and would be difficult to implement.

3. Proposed Alternative
Staff believes that the recommended TMDL reflects a reasoned and reasonable approach to the improvement of beneficial uses of Lake Elsinore and Canyon Lake. The proposed implementation schedule also provides a realistic time frame in which to complete the tasks required by the TMDL.

13. Public Participation

In January 2000, Regional Board staff convened a TMDL Workgroup to assist staff in the development of the Lake Elsinore and Canyon Lake Nutrient TMDL. Active participants in the TMDL Workgroup include representatives from the Riverside County Flood Control and Water Conservation District, the cities of Lake Elsinore, Canyon Lake, Hemet and Moreno Valley, the Santa Ana Watershed Project Authority (SAWPA), the Lake Elsinore and San Jacinto Watershed Authority (LESJWA), the California Department of Fish and Game, Eastern Municipal Water District, Elsinore Valley Municipal Water District, Western Dairymen's Association, Milk Producers Council and the San Jacinto Resource Conservation District. The TMDL Workgroup has been instrumental in assisting Regional Board staff in the development of the Nutrient TMDL. Specific activities of the Workgroup have included compilation of existing data, design, coordination and implementation of the watershed and in-lake monitoring programs, and review of the results of studies conducted in the watershed by both Regional Board staff and other scientists.

In addition to the TMDL Workgroup, stakeholders in the watershed have formed the San Jacinto Watershed Council (Council). The Council includes members of the TMDL Workgroup; however, the Council's scope of activities extends beyond water quality and TMDL issues. For example, the Council has been working with Riverside County staff on issues dealing with the Multi-Species Habitat Plan. While not a member of the Council, Board staff does participate in Council meetings as time allows.

As discussed previously (see Section 5.2), SAWPA obtained a Clean Water Action Section 205(j) grant for conducting the nutrient assessment and modeling analysis. This project was instrumental in the development of the proposed Lake Elsinore and Canyon Lake Nutrient TMDL. In addition to the 205(j) funding, LESJWA obtained a Proposition 13 grant to develop a San Jacinto Watershed Nutrient Management Plan (NMP). The NMP was developed using the database, information and modeling tools utilized for the Lake Elsinore and Canyon Lake Nutrient TMDL development process[15]. An advisory group, a subcommittee of key watershed stakeholders on the San Jacinto Watershed Council, was consulted on a regular basis for input into the NMP. A draft of the San Jacinto Nutrient Management Plan has been completed and is currently under review. The final version is expected to be completed by May 2004.

The San Jacinto NMP provides a strategy for nutrient management in the watershed. The draft NMP discusses key issues regarding watershed characteristics, waterbody impairment, and provides a comprehensive pollutant source assessment with identification and recommendations for projects to reduce those sources of nutrients and improve the water quality in the watershed. Nineteen projects are identified in the draft San Jacinto NMP. Two of these projects are currently planned and funded for Lake Elsinore (through Proposition 13), and two are currently planned and funded for Canyon Lake. Several of the recommended projects propose continuation of the watershed and in-lake water quality monitoring programs. The remaining recommended projects would address nutrient sources and nutrient loading to Canyon Lake and Lake Elsinore

[15] Tetra Tech, Inc., the contractor for the TMDL model development, has also been one of the primary contractors for development of the San Jacinto NMP. Pat Boldt Consulting is the other contractor on the San Jacinto NMP project.

from the watershed through implementation of specific BMPs and/or construction of facilities to remove nutrient sources (*e.g.*, digesters). Table 13-1 provides the draft list of recommended projects and expected benefits. Note that most of the recommended projects will also implement specific elements of the proposed Nutrient TMDL (*e.g.*, monitoring programs, septic system improvements). However, due to that fact that detailed planning and design information is not available for most of the projects on the list at this time, it is not possible to assess whether the implementation of these projects will ensure the compliance of TMDL. Regional Board staff will continue to work closely with the TMDL Workgroup, the San Jacinto River Watershed Council, LESJWA and other stakeholders in the watershed to ensure that TMDL implementation efforts are consistent and coordinated with all of the other watershed improvement projects.

Table 13-1. Benefits of Projects Outlined in the Nutrient Management Plan

Project No.	Project Name	Pollutant Load Control	Habitat Protection	Aesthetic Value	Lake Water Quality	Lake Water Quantity	Addresses TMDL Development	Addresses TMDL Implementation & BMPs
1*	Lake Elsinore In-Lake Nutrient Treatment	X	X	X	X	X?		?
2*	Lake Elsinore Aeration	X	X	X	X			X
3*	Canyon Lake Aeration/ Destratification	X	X	X	X			X
4*	Canyon Lake Dredging	X	X	X	X	X		X
5	Lake Elsinore Water Quality Monitoring				X	X	X	X
6	Development of a Dynamic Water Quality Model of Lake Elsinore				X	X	X	X
7	Canyon Lake Water Quality Monitoring				X	X	X	X
8	Development of a Dynamic Water Quality Model of Canyon Lake				X	X	X	X
9	Structural Urban BMPs	X			X			X
10	Sewer and Septic Improvements	X			X			X
11	Control of Trash in Stream Channels	X	X	X	X			
12	Interception and Treatment of Nuisance Urban Runoff	X			X			X
13	Riparian Habitat Restoration and Development of Agricultural Buffers	X	X	X	X			X
14	Determination of Crop-Specific Agronomic Rates for Guidance in Fertilizer and Manure Application Management	X			X		X	X
15	Assessment of Nutrient Loads to the San Jacinto Watershed as a Result of Flooding in Agricultural Areas	X			X		X	X
16	Regional Organic Waste Digester	X			X			X
17	Development of a Pollutant Trading Model							X
18	Data Collection for Mystic Lake to Support Development of Future Projects		X		X		X	
19	Continued Monitoring of Streamflow and Water Quality Throughout the Watershed				X		X	X

* Projects that are being fully or partly funded by LESJWA.

(from the Draft San Jacinto Nutrient Management Plan by Tetra Tech, Inc., 2004)

14. Staff Recommendation

Direct staff to prepare a Basin Plan amendment and related documentation to incorporate the TMDL for nutrients for Canyon Lake and the Lake Elsinore that is shown in Attachment A for consideration at a future public hearing..

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APPENDIX A

LAKE ELSINORE AND CANYON LAKE NUTRIENT TMDLS, WASTELOAD AND LOAD ALLOCATIONS BASED ON THREE HYDROLOGIC CONDITIONS

Table A-1

Interim Nutrient TMDLs for Canyon Lake and Lake Elsinore based on the three hydrologic conditions identified in the technical report
(interim TP target of 0.1 mg/L and TN of target of 1 mg/L)

Wet Scenario	Phosphorus (kg/yr)		Nitrogen (kg/yr)	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	21,554	4,625	197,370	13,549
External Loading	13,726	17,838	175,254	171,394
Total TMDL	35,280	22,463	372,624	184,943

Moderate Scenario	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	21,554	4,625	197,370	13,549
External Loading	10,024	1,664	4,411	7,149
Total TMDL	31,578	6,289	201,781	20,698

Dry Scenario	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	21,554	4,625	197,370	13,549
External Loading	8,907	1,184	387	4,401
Total TMDL	30,461	5,809	197,757	17,950

Table A-2

Final Nutrient TMDLs for Canyon Lake and Lake Elsinore based on the three hydrologic conditions identified in the technical report
(TP target of 0.05 mg/L and TN target of 0.5 mg/L)

Wet Scenario	Phosphorus (kg/yr)		Nitrogen (kg/yr)	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	9,948	4,625	197,370	13,549
External Loading	4,491	8,919	87,627	85,697
Total TMDL	14,439	13,544	284,997	99,246

Moderate Scenario	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	9,948	4,625	197,370	13,549
External Loading	2,732	897	2,205	3,574
Total TMDL	12,680	5,522	199,575	17,123

Dry Scenario	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	9,948	4,625	197,370	13,549
External Loading	2,428	592	194	2,200
Total TMDL	12,376	5,217	197,564	15,749

Table A-3. Interim TMDL, Wasteload and Load Allocations TMDL for Lake Elsinore under three hydrologic conditions (interim TP target of 0.1 mg/L and TN target of 1.0 mg/L)

Scenario I: Wet condition as in 1998						
	Nitrogen load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**372,624**	**351,563**		**35,280**	**78,283**	
WLA	40,412			2,210		
Supplemental water	0			0		
Urban	23,952	20,868	none	1,341	4432	70
CAFO	16,459	14,340	none	870	2875	70
LA	332,212			33,070		
Internal Sediment Source	197,370	197,370	0	21,554	33,160	35
Atmospheric Deposition	11,702	11,702	0	108	108	0
Agriculture	56,259	49,014	none	6,615	21867	70
Open/Forest	22,890	19,943	none	3,890	12857	70
Septics	43,991	38,326	none	903	2984	70
MOS	0			0		
Scenario II: Moderate condition as in 1994						
	Nitrogen load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**201,781**	**262,006**		**31,578**	**41,212**	
WLA	0			4,640		
Supplemental water	0	40,676	100	1,845	7152	74
Urban	0	4,399	100	2,684	263	
CAFO	0	623	100	111	11	
LA	201,781			26,938		
Internal Sediment Source	197,370	197,370	0	21,554	33,160	35
Atmospheric Deposition	4,411	11,702	62	108	108	0
Agriculture	0	4,384	100	3,210	315	na
Open/Forest	0	1,336	100	1,690	166	na
Septics	0	1,516	100	376	37	na
MOS	0			0		
Scenario III: Dry condition as in 2000						
	Nitrogen load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**197,757**	**250,532**		**30,461**	**40,884**	
WLA	0			5,835		
Supplemental water	0	40,676	100	4,920	7,152	31
Urban	0	201	100	854	102	none
CAFO	0	21	100	61	7	none
LA	197,757			24,626		
Internal Sediment Source	197,370	197,370	0	21,554	33,160	35
Atmospheric Deposition	387	11,702	97	108	108	0
Agriculture	0	231	100	1,988	238	none
Open/Forest	0	146	100	622	74	none
Septics	0	184	100	354	42	none
MOS	0			0		

Table A-4. Interim TMDL, Wasteload and Load Allocations for Canyon Lake under three hydrologic conditions (interim TP target of 0.1 mg/L and TN target of 1.0 mg/L)

Scenario I: Wet condition as in 1998						
	N Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	P Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**184,943**	**145977**		**22,463**	**47967**	
WLA	42,433			2,767		
Supplemental water	0			0		
Urban	23,812	18337	none	1,590	3893	59
CAFO	18,621	14340	none	1,177	2881	59
LA	142,510			19,696		
Internal Sediment Source	13,549	13549	0	4,625	4625	0
Atmospheric Deposition	1,918	1918	0	221	221	0
Agriculture	61,619	47452	none	8,839	21635	59
Open/Forest	22,844	17591	none	4,941	12093	59
Septics	42,580	32790	none	1,070	2619	59
MOS	0			0		
Scenario II: Moderate condition as in 1994						
	N Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	P Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**20,698**	**26620**		**6,289**	**7553**	
WLA	2,356			506		
Supplemental water	248	248	0	0		
Urban	1,824	3992	54	478	896	47
CAFO	284	621	54	28	53.5	47
LA	18,342			5,783		
Internal Sediment Source	13,549	13549	0	4,625	4625	0
Atmospheric Deposition	1,918	1,918	0	221	221	0
Agriculture	1,897	4152	54	728	1366	47
Open/Forest	450	985	54	168	315	47
Septics	528	1155	54	40	76	47
MOS	0			0		
Scenario III: Dry condition as in 2000						
	N Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	P Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**17,950**	**27199**		**5,809**	**6522**	
WLA	907			223		
Supplemental water	247	247	0	0	0	
Urban	554	2845	81	206	359	43
CAFO	106	543	81	17	29.5	43
LA	17,043			5,586		
Internal Sediment Source	13,549	13549	0	4,625	4625	0
Atmospheric Deposition	1,918	1918	0	221	221	0
Agriculture	798	4099	81	536	931.5	43
Open/Forest	166	855	81	113	196	43
Septics	612	3143	81	92	159.5	43
MOS	0			0		

Table A-5. Final TMDL, Wasteload and Load Allocations TMDL for Lake Elsinore under three hydrologic conditions (final TP target of 0.05 mg/L and TN target of 0.5 mg/L)

Scenario I: Wet condition as in 1998						
	Nitrogen load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**284,997**	**351,563**		**14,439**	**78,283**	
WLA	18,760			711		
Supplemental water	0			0		
Urban	11,119	20,868	47	432	4432	90
CAFO	7,641	14,340	47	280	2875	90
LA	266,237			13,728		
Internal Sediment Source	197,370	197,370	0	9,948	33,160	70
Atmospheric Deposition	11,702	11,702	0	108	108	0
Agriculture	26,117	49,014	47	2,129	21867	90
Open/Forest	10,626	19,943	47	1,252	12857	90
Septics	20,422	38,326	47	291	2984	90
MOS	0			0		
Scenario II: Moderate condition as in 1994						
	Nitrogen load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**199,575**	**262,006**		**12,680**	**41,212**	
WLA	0			2,115		
Supplemental water	0	40,676	100	1,845	7152	74
Urban	0	4,399	100	259	263	2
CAFO	0	623	100	11	11	2
LA	199,575			10,565		
Internal Sediment Source	197,370	197,370	0	9,948	33,160	70
Atmospheric Deposition	2,205	11,702	81	108	108	0
Agriculture	0	4,384	100	310	315	2
Open/Forest	0	1,336	100	163	166	2
Septics	0	1,516	100	36	37	2
MOS	0			0		
Scenario III: Dry condition as in 2000						
	Nitrogen load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**197,564**	**240,870**		**12,376**	**40,884**	
WLA	0			2,051		
Supplemental water	0	40,676	100	1,968	7,152	72
Urban	0	201	100	77	102	24
CAFO	0	21	100	6	7	24
LA	197,564			10,325		
Internal Sediment Source	197,370	197,370	0	9,948	33,160	70
Atmospheric Deposition	194	2,040	90	108	108	0
Agriculture	0	231	100	180	238	24
Open/Forest	0	146	100	56	74	24
Septics	0	184	100	32	42	24
MOS	0			0		

Table A-6. Final TMDL, Wasteload and Load Allocations for Canyon Lake under three hydrologic conditions (final TP target of 0.05 mg/L and TN target of 0.5 mg/L)

Scenario I: Wet condition as in 1998						
	N Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	P Load Allocation(kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**99,246**	**145,977**		**13,544**	**47,967**	
WLA	20,976			1,366		
Supplemental water	0			0		
Urban	11,771	18337	36	785	3893	80
CAFO	9,205	14340	36	581	2881	80
LA	78,270			12,178		
Internal Sediment Source	13,549	13549	0	4,625	4625	0
Atmospheric Deposition	1,918	1918	0	221	221	0
Agriculture	30,461	47452	36	4,364	21635	80
Open/Forest	11,293	17591	36	2,439	12093	80
Septics	21,049	32790	36	528	2619	80
MOS	0			0		
Scenario II: Moderate condition as in 1994						
	N Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	P Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**17,123**	**26,372**		**5,522**	**7,553**	
WLA	843			237		
Supplemental water	247	247	0	0		
Urban	516	3992	87	224	896	75
CAFO	80	621	87	13	53.5	75
LA	16,280			5,285		
Internal Sediment Source	13,549	13549	0	4,625	4625	0
Atmospheric Deposition	1,918	1,918	0	221	221	0
Agriculture	536	4152	87	341	1366	75
Open/Forest	127	985	87	79	315	75
Septics	149	1155	87	19	76	75
MOS	0			0		
Scenario III: Dry condition as in 2000						
	N Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)	P Load Allocation (kg/yr)	Existing load (kg/yr)	Reduction (%)
TMDL	**15,749**	**26,952**		**5,217**	**6,522**	
WLA	257			86		
Supplemental water	247	247	0	0	0	
Urban	9	2845	100	80	359	78
CAFO	2	543	100	7	29.5	78
LA	15,491			5,131		
Internal Sediment Source	13,549	13549	0	4,625	4625	0
Atmospheric Deposition	1,918	1918	0	221	221	0
Agriculture	12	4099	100	206	931.5	78
Open/Forest	3	855	100	43	196	78
Septics	9	3143	100	35	159.5	78
MOS	0			0		

APPENDIX B

LAKE ELSINORE WATER QUALITY MODEL

M. ANDERSON (2003)

Note: This model was used to calculate the total phosphorus load capacity for Lake Elsinore. The model is currently being updated and refined. The update includes sensitivity analysis to address the uncertainties in the parameters in the model. A nitrogen model is also under development.

Water Quality in Lake Elsinore: Model Development and Results

Michael Anderson

Summary

Water quality data over the past decade were analyzed and used to develop a simple dynamic model for Lake Elsinore. The model was able to reproduce water quality in the lake from 1993-present. The model was then used to predict water quality under a variety of scenarios, including continued declines in lake elevation, stabilized lake levels with recycled water of varying nutrient contents, and selected in-lake management techniques.

Analysis of Lake Elsinore Data: 1993 - 2002

Data available for Lake Elsinore for the period 1993-1997 and 2000-2002 were provided by the SARWQCB. This data included water quality measurements made by Black and Veatch, Montgomery-Watson, EVMWD, SARWQCB and others. Recent data collected by UCR have also been added.

Lake elevation has changed quite dramatically over the past decade (Fig. 1). A single measurement made November 23, 1992 was not included (lake surface elevation of 1229 ft), but reflects the low water conditions also present on January 5, 1993 (Fig. 1). Lake elevation increased substantially over the next 3 months, and reached a maximum elevation of 1258.5 ft. Surface elevation then declined to approximately 1253 ft before increasing again in the winter storms of 1995. Limited rainfall and runoff during winter of 1996 and 1997 resulted in continued reductions in lake elevation over this period, with the lake elevation declining below 1250 ft. The available surface elevation (and related water quality) record stops and then picks up again in 2000-present (Fig. 1).

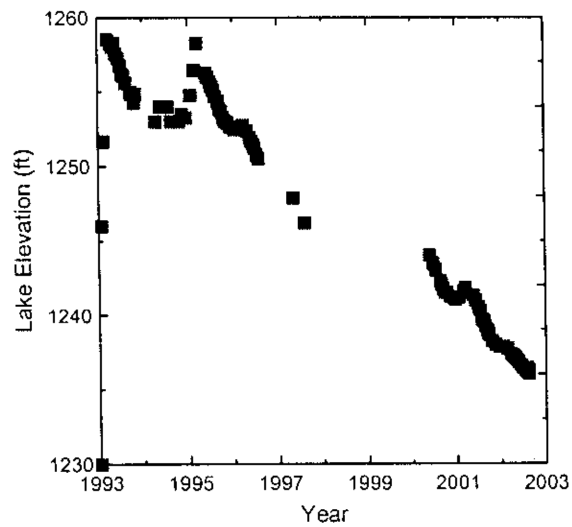

Fig. 1.

The storage-elevation data from Black and Veatch (1995) was used to develop an empirical equation allowing elevation data to be converted to lake volumes (Fig. 2a). The data could be quite reasonably described using a 2nd-order polynomial (R^2=0.999) of the form:

$$Vol\ (af) = 51{,}200{,}209 - 85{,}457.1 * Elev\ (ft) + 35.63 * Elev\ (ft)^2 \qquad (1)$$

Equation (1) was then used to predict lake volumes over time (Fig. 2b).

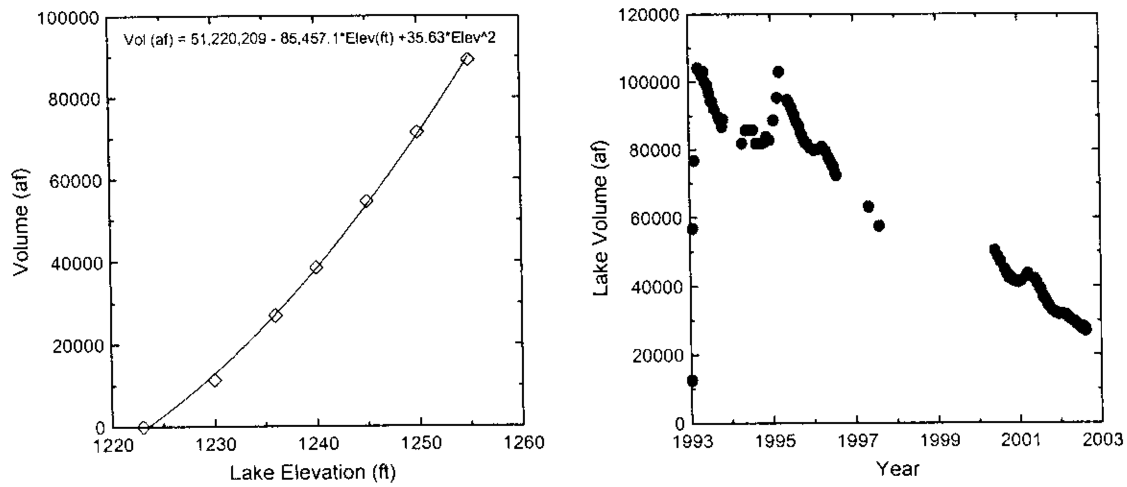

Fig. 2.

Water quality changed substantially over this time period as well (*e.g.*, Fig. 3). Early 1993 was characterized by very high total P concentrations (>0.6 mg/L) but relatively low total N levels (2-3 mg/L). Thus, as previously recognized, the lake was rather strongly N-limited during this time. Total P concentrations decreased significantly over the next 4 years, while total N increased slightly (Fig. 3). The intersection of the data coincides with at TN:TP ratio of 10:1, so the lake was relatively balanced with respect to nutrients in 1995-1996. More recently, TN concentrations have exceeded 4 mg/L while TP levels have typically averaged about 0.15 mg/L, so the lake is now more typically P-limited, especially during the summer (Fig. 3).

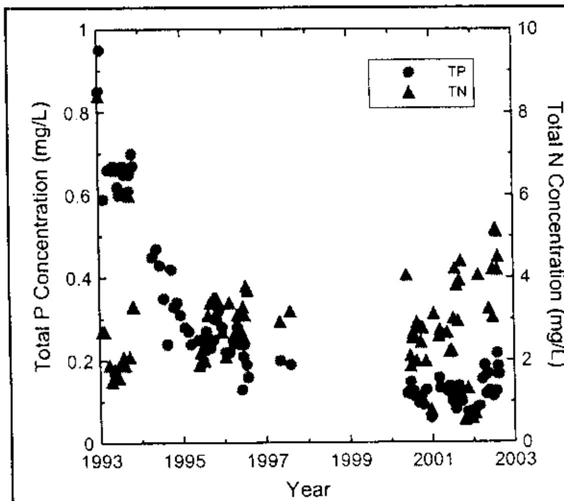

Fig. 3.

Chlorophyll levels and TN:TP ratios varied significantly over this time period as well (Fig. 4). High chlorophyll levels were found during the later summer following the large inputs of P of the winter, 1993. As noted, however, the lake was strongly N-limited (Fig. 4). Summer chlorophyll levels decreased over the next several years. More recently, summer chlorophyll levels have increased from about 100 to 150 and >300 µg/L over the past 3 summers (2000-2002) (Fig. 4). Winter chlorophyll levels (Fig.4) have been generally quite low and typically coincide with the highest TP levels in the lake (Fig. 3).

Plotting TP and TN concentrations as a function of lake elevation provides some interesting results (Fig. 4). Specifically, high TP concentrations (>0.5 mg/L) have, in fact, been noted both at very low lake elevations (~1230 ft) and very high surface elevations (Fig. 4).

The cluster of data near 1240 ft elevation represents recent conditions (2000-present), where lake levels have declined and TP (and TN) levels have begun increasing. The red and brown lines are 2nd-order polynomial and linear fits to the TP and TN data, respectively. These lines are principally used to help highlight general trends in N and P concentrations with lake elevation and do not have any particular significance, especially at high lake levels. Nevertheless, the figure suggests that the recent increases in TP and TN concentrations, coinciding with lake elevation decreases from about 1242 to 1236 are potentially on pace to return to the very high levels found in late 1992 and early 1993 during the lowest recent recorded lake levels.

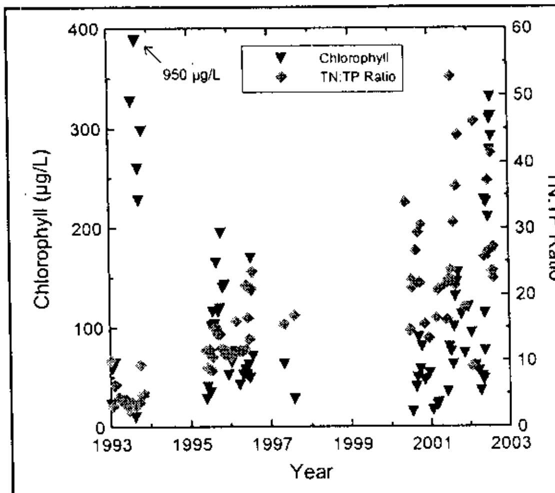

Fig. 4.

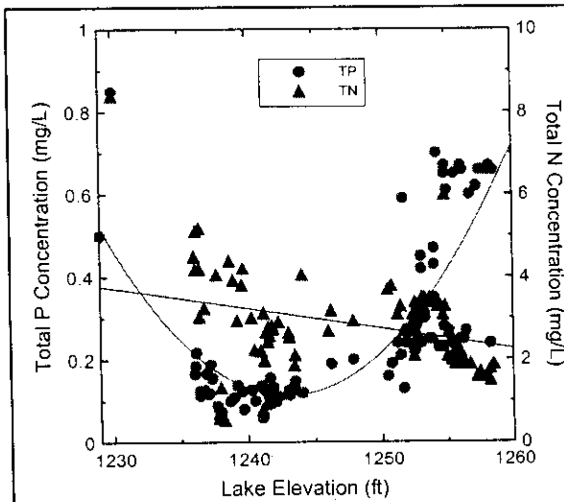

Fig. 5.

Modeling Nutrient Concentrations

The rapid decline in TP concentrations from 1993-1996 (Fig. 3) suggests a first-order loss process. Since the lake volume changed over this time period due to evaporative losses and inflows (relatively little water was lost as outflows; Montgomery-Watson, 1997), with corresponding external loading, a simple coupled water and P-balance model was developed.

The change in nutrient mass within the lake was calculated as:

$$\frac{dM}{dt} = \frac{dVC}{dt} = V\frac{dC}{dt} + C\frac{dV}{dt} \qquad (2)$$

where M is the total mass in the system (kg), V is the lake volume (m^3), C is the concentration (mg/m^3) and t is time. The 1st term on the right-hand side of the equation can be written as:

$$V\frac{dC}{dt} = Q_{in}C_{in} - Q_{out}C_{out} - \frac{v}{H}CV \qquad (3)$$

where Q_{in} is the flow entering the lake (m^3/yr), Q_{out} is the flow exiting the lake (m_3/yr), C_{in} and C_{out} are the influent and effluent concentrations, respectively, v is the net settling velocity (m/yr) and H is the mean lake depth (m).

A number of factors influence the net settling velocity in a lake, including the rate of particle settling and the rates of internal loading and resuspension. It can be shown that the net sedimentation rate, v, is related to the settling rate, v_s (m/yr), the internal loading rate parameter, k (m/yr), and a resuspension velocity, r (m/yr) by:

$$v = v_s - \frac{C_{sed}(k + r)}{C} \tag{4}$$

where C_{sed} is the volumetric sediment P concentration (mg/m^3) and C, as defined above, is the water column TP concentration (mg/m^3). Thus, the net sedimentation rate will be dependent upon the rate in internal loading (taken here to include both dissolved and particulate P, with dissolved being converted to algal forms within the water column), the rate of resuspension, the P concentration in the sediments (assumed to be constant), and the concentration of TP in the water column (eq 4).

The internal loading rate parameter, k, is effectively then a velocity term describing the rate at which TP is released from the sediments. This parameter is expected to vary depending upon the conditions at the lake. For example, higher TP concentrations in the water column would result in greater delivery of particulate P to the bottom sediments, which could, in turn, result in higher recycling rates. To assess this, average P internal loading rates, either measured (Anderson, 2001) or estimated (Mongtomery-Watson, 1997), were plotted as a function of annual average TP concentratons (Fig. 6). Since the late summer P flux rates were previously found to be comparable to the annual average flux rates (Anderson, 2001), recent core-flux results from a site within the high-speed zone (12.3 mg/m^2/d) were used as an estimate for 2002. A linear relationship was found between average TP concentration and average P internal loading rate (Fig. 6).

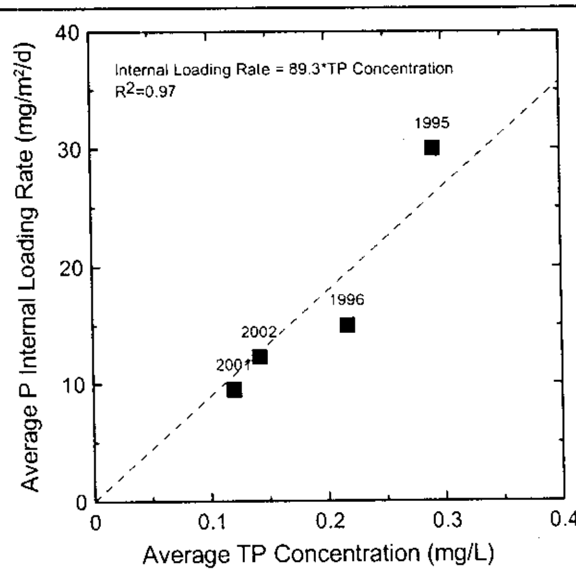

Fig. 6.

Sediment resuspension rates are also expected to vary depending upon lake conditions, in this case, specifically as a function of lake elevation. The potential for resuspension at Lake Elsinore is high given its shallow depth, relatively long fetch and periodic strong winds. Specifically, resuspension can occur when deep-water waves enter water shallower than one-half the wave length (Bloesch, 1995). The wavelength, L, of a deepwater wave is related to its period, T, by the relation:

$$L = \frac{gT^2}{2\pi} \tag{5}$$

where g is the gravitational constant (Martin and McCutcheon, 1999). A wave's period can be estimated using the empirical equation developed by the US Army Coastal Engineering Research Center (Carper and Bachmann, 1984) that states:

$$T = \frac{2.4\pi U \tanh\left[0.077\left(\frac{gF}{U^2}\right)^{0.25}\right]}{g} \quad (6)$$

where U is the wind speed and F is the fetch.

Using these relationships, the wind-mixed depth, taken as one-half the wavelength, L (Martin and McCutcheon, 1999), was calculated for a wind speeds of 2.5, 5 and 10 m/s assuming a 3 km fetch. These lower wind speeds represent the range in typical daily average wind speeds often found at the lake, while this higher wind speed of 10 m/s is a relatively frequently observed sustained wind speed during storms, Santa Ana winds, and other meteorological conditions. As one can see, under relatively low wind speeds, resuspension due to oscillatory horizontal motion immediately above the sediments at a wind speed of 2.5 m/s is expected only at depths <1 m. This increases to 2.1 m at wind speeds of 5 m/s, and to a depth of 4.4 m when sustained wind speeds reach 10 m/s. The relationship between fetch, windspeed and critical or mixing depth can be seen more fully in Fig. 7.

Table 1. Predicted wave properties as a function of windspeed for a 3 km fetch.

Windspeed (m/s)	Wave Period (s)	Wavelength (m)	Critical Depth (m)
2.5	1.08	1.8	0.9
5.0	1.63	4.1	2.1
10.0	2.37	8.8	4.4

Using bathymetric data, one can then estimate the area of lake bottom sediments that could potentially be mobilized by wind (Carper and Bachmann, 1984). For example, using the bathymetric data developed at lake elevation near 1242 ft and winds principally out of the WSW, the eastern shore possesses the greatest potential for sediment resuspension, with sediment as deep as approximately 4 m potentially being resuspended. Under these conditions, it is estimated that about 4% of the lake bottom will occur within the wind-mixed region. Recognizing that the finer, organic sediments are the most readily mobilized, it is also instructive to consider that proportion of the

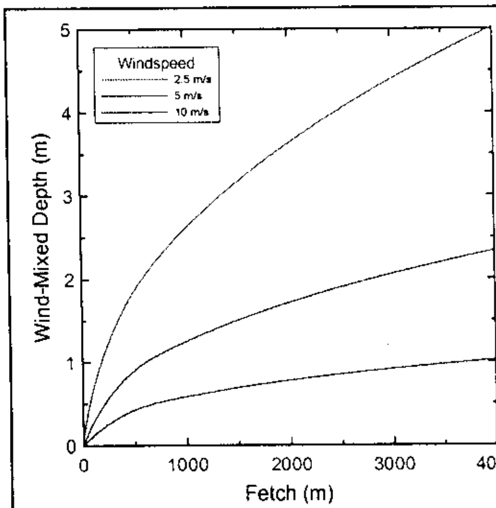

Fig. 7.

lake bottom comprised of type II or III sediments that may be actively resuspended (*i.e.*, occur within the wind-mixed region) (Fig. 8). The percent area of bottom sediments potentially resuspended will vary strongly depending upon lake elevation, with relatively little resuspension at high elevations and extensive resuspension potential at low surface elevations (Fig. 8).

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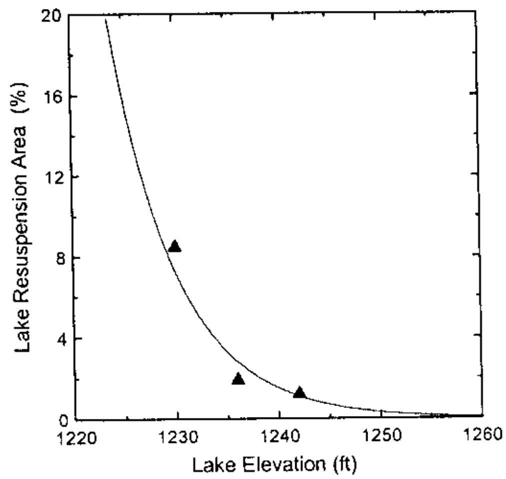

Fig. 8. Area of lake bottom prone to resuspension (type II and III sediments only) as a function of lake elevation.

The data in Fig. 8 were used in conjunction with sediment trap and other nutrient budget data (Anderson, 2001) to estimate the elevation-dependent resuspension velocity term (r) in eq 4. Specifically, resuspension of the fine organic (type II and III) sediments was assumed to be very low at high elevations and increase exponentially with decreasing elevation following Fig. 8.

Importantly, then, the net sedimentation rate, v, can be allowed to vary depending upon water quality conditions at the lake.

The change in volume of the lake, dV/dt, can be written as:

$$\frac{dV}{dt} = Q_{in} + PA_s - Q_{out} - EA_s \tag{7}$$

where P is the precipitation rate (m/yr), A_s is the surface area of the lake (m^2), and E is the evaporation rate (m/yr). Available flow and precipitation data were used, although inflows were estimated for some parts of the simulation period (*e.g.*, 1998-1999). Evaporation rates were assumed to range from 2 ft/yr during the winter-spring months (December-May) to 6.6 ft/yr during the summer months. The above system of ordinary differential equations (eqs 2, 3 and 7) was solved using a forward difference scheme and a timestep of 0.05 yr. Hydrologic balance calculations yielded reasonable agreement between measured and observed lake volumes (Fig. 9).

Solution for TP concentrations in the above coupled ordinary differential equations requires an estimate of the net settling velocity (eq 4). The net settling velocity, v, was initially estimated by simply fitting an exponential to the 1993-1996 data, which yielded a 1st-order constant m of 0.38 yr^{-1}. Since $m=v/H$, and the average depth of the lake over this time period was about 7.5 m, v was first set to 2.85 m/yr. Somewhat better agreement was found when v was increased to 3.8 m/yr (or 0.01 m/d) to offset for evaporative concentration effects. This empricially-derived estimate of *v* (3.8 m/yr) from available water quality data (Fig. 3) is within the range of net settling velocities generally found for lakes (3-30 m/yr) (Thomann and Mueller, 1984). A net settling velocity on the low side of the above range in *v* values is consistent with the shallow and well-mixed condition of Lake Elsinore.

Since C_{sed} was assumed to be constant, *k* allowed to vary with water column TP concentrations (Fig. 6) following the empirical relationship 1.3×10^{-4} x C (mg/m^3) (m/yr), and *r* was taken to be very small (0.002 m/yr), eq 4 was rearranged and solved for v_s, the TP settling rate (m/yr). Doing this, one calculates a settling rate of 37 m/yr or ~0.1m/d. This settling rate is thought to represent largely algal TP. Encouragingly enough, this settling velocity comes in right at typical algal settling rates of 0.1-0.3 m/d measured in *in situ* experiments and used in other modeling studies (Thomann and Mueller, 1984), including the work conducted on Lake Elsinore by Montgomery-Watson (Montgomery-Watson,1997).

Using these independently-derived model parameters, one notes that the model actually does quite a reasonable job of reproducing measured TP concentrations over this time period (Fig. 9). The model correctly predicts a dramatic decline it TP concentrations over the period 1993-1996, from levels >0.6 mg/L to approximately 0.2 mg/L. The model then predicts TP levels to decline more slowly over the next couple of years, reaching a minimum concentration of 0.138 mg/L in May 2000, followed by an increase in TP levels to 0.19 mg/L by the end of 2002 (Fig. 9). It should again be noted that some assumptions about precipitation, runoff volumes and runoff TP concentrations were made for 1998-1999, so the predictions for this time period are tentative. Moreover, no lake elevation, volume or water quality data for the period 1998-1999 are readily available, so it is not possible to compare predicted and measured values for this period.

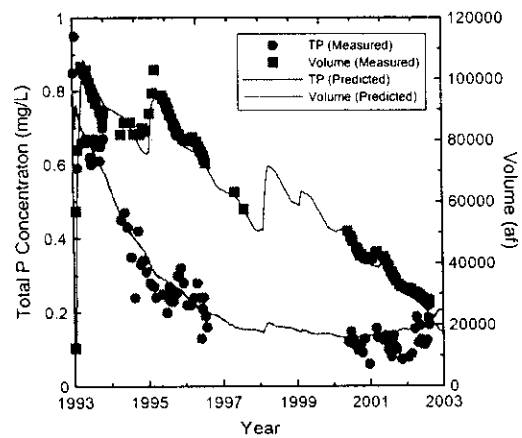

Fig. 9.

With some evidence supporting the applicability of the model for predicting water quality in Lake Elsinore, it is instructive to forecast predicted water quality following implementation of different restoration activities. Under controlled conditions, *e.g.*, regular addition of recycled water sufficient to maintain a lake elevation near 1242 ft, steady-state approximations are appropriate. Under steady-state conditions (*i.e.*, dV/dt=0 and dC/dt=0) and assuming Q_{out} is 0, eq 3, following substitution of eq 4 for *v*, reduces to:

$$C_{ss} = \frac{\left(\frac{Q_{in} C_{in} H}{V} + (k + r) C_{sed}\right)}{v_s} \qquad (8)$$

When C_{in} is 0, eq 6 simply reduces to:

$$C_{ss} = \frac{(k+r)C_{sed}}{v_s} \tag{9}$$

Using the nutrient data developed for 2000-2001 (Anderson, 2001), one estimates an internal loading rate constant, k of 0.0156 m/yr, a resuspension velocity of 0.0021 m/yr, a volumetric sediment TP concentration of 247,000 mg/m^3 and a settling rate, v_s, of 37.4 m/yr. Substituting these values into eq 9, one estimates a steady-state TP concentration of 0.117 mg/L. This value is in excellent agreement with the annual average TP concentration of 0.119 mg/L reported by the RWQCB for the 2000-2001 period.

The water quality associated with this TP concentration in the lake was predicted using empirical relationships. The relationship of Dillon and Rigler (1974) was used to predict lake chlorophyll levels, where:

$$\log chl\ (\mu g/L) = 1.449 \log TP\ (ug/L) - 1.136 \tag{10}$$

The Lake Elsinore-derived relationship between chlorophyll and Secchi depth (m) (Anderson, 2002), here rearranged to solve for Secchi depth, was used to estimate lake transparencies:

$$Secchi\ Depth\ (m) = 67.16\,/\,(Chlorophyll\ (\mu g/L) + 55.98) \tag{11}$$

The predicted chlorophyll level for the lake at a stable 1242 ft elevation (without external loads) is 73 µg/L, which is expected to produce a transparency of 0.52 m. These values are in reasonable agreement with previously reported measured values for chlorophyll and Secchi depth of 52 µg/L and 0.62 m, respectively.

The model was then used to predict steady-state TP, chlorophyll and transparency values for the lake subject to recycled water addition at different TP inlet concentrations (Table 1). A preliminary sensitivity analysis showed that the internal loading (*k*) and resuspension (*r*) terms drive the predicted TP levels in the lake; thus two different model parameterizations were used to estimate the likely range (*i.e.*, uncertainty) in predicted steady-state water quality in the lake.

Table 1. Predicted lake water quality resulting from addition of 15,000 af/yr at different influent P concentrations.

Influent P Conc (mg/L)	Lake TP Conc (mg/L)	Chlorophyll (µg/L)	Secchi Depth (m)
0	0.100 - 0.123	58 - 78	0.50 - 0.59
0.05	0.113 - 0.131	69 - 85	0.48 - 0.54
0.1	0.127 – 0.140	82 - 94	0.45 - 0.49
0.5	0.208 - 0.236	167 - 202	0.26 - 0.30
1.0	0.293 - 0.374	274 - 391	0.15 - 0.20

[a]assuming 15,000af/yr as some mix of recycled water, runoff, groundwater and other sources

Adding the equivalent of 15,000 af of water with no P, the predicted TP and chlorophyll concentrations in the lake were in good agreement with those values predicted using eq 9. The difference appears to be due to numerical dispersion and rounding errors in the model simulation. Notwithstanding such differences, it can be seen that low concentrations of P in the recycled water are predicted to have modest impacts on lake water quality; for example, 15,000 af of water at a P concentration of 0.05 mg/L is expected to only increase the TP by 0.008 – 0.013 mg/L and raise the chlorophyll concentrations by 7 - 11 µg/L. Such an increase in chlorophyll is expected to lower the Secchi depth by 0.02 - 0.05 m, to about 0.5 m. Increasing the influent P concentration to 0.1 mg/L is expected to increase average TP levels in the lake by up to 27%, while the chlorophyll level is expected to increase to 82 - 94 µg/L. Higher concentrations of P in the influent are expected to have more substantial effects on the water quality (Table 1). It should be noted that up to 3 simulation years were required before a steady-state condition in the lake was approached.

While the above projections were made assuming internal loading and resuspension rates were unchanged from the natural conditions in the lake, it is instructive to evaluate recycled water inputs to the lake with simultaneous internal load reductions. For these calculations, a reduction of 30% in the internal loading rate was assumed (Table 2).

Table 2. Predicted lake water quality resulting from addition of 15,000 af/yr at different influent P concentrations, with 30 % reduction in internal loading rate.

Influent P Conc (mg/L)	Lake TP Conc (mg/L)	Chlorophyll (µg/L)	Secchi Depth (m)
0	0.036 – 0.076	12.8 – 38.9	0.71 - 0.98
0.05	0.040 – 0.079	15.4 – 41.1	0.69 - 0.94
0.1	0.045 – 0.082	18.2 – 43.5	0.68 - 0.90
0.5	0.084 – 0.108	45.2 – 65.9	0.56 - 0.67
1.0	0.133 – 0.152	87.1 – 105.6	0.42 - 0.47

A 30% reduction in internal loading rate is predicted to yield a 38 - 61% reduction in lake TP concentration, with correspondingly low chlorophyll levels and high transparencies (Table 2) relative to the natural condition reflected in Table 1. This (unintuitive) lake response to internal load reductions comes from the coupling of the internal loading rate and the water column concentration (Fig. 6). That is, a reduction in the internal loading rate by some amount (e.g., 30%), results in a lowering of the water column concentration; this lower water column concentration, in turn, supports a still lower subsequent internal loading rate. Thus, up to a 2x net reduction in steady-state TP concentrations in the lake may be achieved for a given internal loading rate reduction.

A consequence of this is that internal load reductions, *e.g.*, through aeration or other control strategies, appear to allow relatively high levels of P in recycled water to be added to the lake (Table 2). Ongoing refinements to the model should improve its predictive power, especially at low influent P concentrations where relatively large uncertainties exist.

Discussion

Conclusions

References

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ATTACHMENT A

Resolution No. R8-2004-0037

To be submitted at a later date

ATTACHMENT TO RESOLUTION NO. R8-2004-0037

Amendment to the Santa Ana Region Basin Plan

Chapter 5 - Implementation Plan

(NOTE: The following language is proposed to be inserted into Chapter 5 of the Basin Plan. If the amendments are approved, corresponding changes will be made to the Table of Contents, the List of Tables, page numbers, and page headers in the plan. Due to the two-column page layout of the Basin Plan, the location of tables in relation to text may change during final formatting of the amendments. For formatting purposes, the maps may be redrawn for inclusion in the Basin Plan, and the final layout may differ from that of the draft.)

Lake Elsinore/San Jacinto River Watershed

The Lake Elsinore/San Jacinto River Watershed is located in Riverside County and includes the following major waterbodies; Lake Hemet, San Jacinto River, Salt Creek, Canyon Lake and Lake Elsinore. The total drainage area of the San Jacinto River watershed is approximately 782 square miles. Over 90 percent of the watershed (735 square miles) drains into Canyon Lake. Lake Elsinore is the terminus of the San Jacinto River watershed. The local tributary area to Lake Elsinore, consisting of drainage from the Santa Ana Mountains and the City of Lake Elsinore, is 47 square miles.

Land use in the watershed includes open/forested, agricultural (including concentrated animal feeding operations such as dairies and chicken ranches, and irrigated cropland), and urban uses, including residential, industrial and commercial. Vacant/open space is being converted to residential uses as the population in the area expands. The municipalities in the watershed include the cities of San Jacinto, Hemet, Perris, Canyon Lake, Lake Elsinore and portions of Moreno Valley and Beaumont

1. Lake Elsinore and Canyon Lake Nutrient Total Maximum Daily Load (TMDL)

Lake Elsinore and Canyon Lake are not attaining water quality standards due to excessive nutrients (nitrogen and phosphorus). Reports prepared by Regional Board staff describe the impact nutrient discharges have on the beneficial uses of Lake Elsinore and Canyon Lake (Ref. #1, 2] Lake Elsinore was formed in a geologically active graben area and has been in existence for thousands of years. Due to the mediterranean climate and watershed hydrology, fluctuations in the level of Lake Elsinore have been extreme, with alternate periods of a dry lake bed and extreme flooding. These drought/flood cycles have a great impact on lake water quality. Fish kills and excessive algae blooms have been reported in Lake Elsinore since the early 20th century. As a result, in 1994, the Regional Board placed Lake Elsinore on the 303(d) list of impaired waters due to excessive levels of nutrients.

Canyon Lake, located approximately 2 miles upstream of Lake Elsinore, was formed by the construction of Railroad Canyon Dam in 1928. Approximately 735 square miles of the 782 square mile San Jacinto River watershed drain to Canyon Lake. During most years, runoff from the watershed terminates at Canyon Lake without reaching Lake Elsinore, resulting in the buildup of nutrients in Canyon Lake. While Canyon Lake does not have as severe an eutrophication problem as Lake Elsinore, there have been periods of algal blooms and occasional fish kills. Accordingly, in 1998, the Regional Board added Canyon Lake to the 303(d) list of impaired waters due to eutrophication.

A TMDL technical report prepared by Regional Board staff describes the nutrient related problems in Canyon Lake and Lake Elsinore in greater detail and discusses the technical basis for the TMDL that follows (Ref. # 3).

A. Lake Elsinore and Canyon Lake Nutrient TMDL Numeric Targets

Numeric targets for Lake Elsinore and Canyon Lake are based on reference conditions when beneficial uses in the lakes were not significantly impacted by nutrients. As shown in Table 5-9n, both "causal and response" interim and final numeric targets are specified for both lakes. Causal targets are those for phosphorus and nitrogen. Phosphorus is the primary limiting nutrient in Lake Elsinore and Canyon Lake, and nitrogen can be a limiting nutrient under certain conditions. Response targets include chlorophyll *a* and dissolved oxygen. These targets are specified to assess water quality improvements in the lakes.

Table 5-9n
Lake Elsinore and Canyon Lake Nutrient TMDL Numeric Targets*

Indicator	Lake Elsinore	Canyon Lake
Total P concentration (Interim)	Annual average no greater than 0.1 mg/L; to be attained no later than 2009	Annual average no greater than 0.1 mg/L; to be attained no later than 2009
Total P concentration (Final)	Annual average no greater than 0.05 mg/L; to be attained no later than 2019	Annual average no greater than 0.05 mg/L; to be attained no later than 2019
Total N concentration (Interim)	Annual average no greater than 1.0 mg/L; to be attained no later than 2009	Annual average no greater than 1.0 mg/L; to be attained no later than 2009
Total N concentration (Final)	Annual average no greater than 0.5 mg/L; to be attained no later than 2019	Annual average no greater than 0.5 mg/L; to be attained no later than 2019
Chlorophyll *a* concentration (Interim)	Summer average no greater than 40 ug/L; to be attained no later than 2009	Summer average no greater than 40 ug/L; to be attained no later than 2009
Chlorophyll *a* concentration (Final)	Summer average no greater than 25 ug/L; to be attained no later than 2019	Summer average no greater than 25 ug/L; to be attained no later than 2019
Dissolved oxygen concentration (Interim)	Depth average no less than 5 mg/L; to be attained no later than 2009	Minimum of 5 mg/L above thermocline and no less than 2 mg/L in hypolimnion; to be attained no later than 2009
Dissolved oxygen concentration (Final)	No less than 5 mg/L 1 meter above lake bottom and no less than 2 mg/L from 1 meter to lake sediment; to be attained no later than 2019	Daily average in hypolimnion no less than 5 mg/L; to be attained no later than 2019.

* compliance with targets to be achieved as soon as possible, but no later than the date specified

B. Lake Elsinore and Canyon Lake Nutrient TMDL, WLAs and LAs and Compliance Dates

Phosphorus and nitrogen TMDLs for Canyon Lake and Lake Elsinore that will implement the numeric targets, and thereby attain water quality standards, are shown in Table 5-9o. Wasteload allocations for point source discharges and load allocations for nonpoint source discharges are shown in Tables 5-9p and 5-9q.

Table 5-9o
Nutrient Load Targets and Compliance Dates for Lake Elsinore and Canyon Lake

TMDL	Interim Total Phosphorus TMDL (kg/yr)[a]	Final Total Phosphorus TMDL (kg/yr)[b]	Interim Total Nitrogen TMDL (kg/yr)[a]	Final Total Nitrogen TMDL (kg/yr)[b]
Canyon Lake	8,708	6,678	66,680	44,041
Lake Elsinore	31,505	12,843	257,387	227,379

[a] Interim compliance to be achieved as soon as possible, but no later than December 31, 2009.
[b] Final compliance to be achieved as soon as possible, but no later than December 31, 2019.

Table 5-9p
Lake Elsinore
Nitrogen and Phosphorus Wasteload and Load Allocations

Lake Elsinore Nutrient TMDL	Interim Total Phosphorus Load Allocation (kg/yr)[a, c]	Final Total Phosphorus Load Allocation (kg/yr)[b, c]	Interim Total Nitrogen Load Allocation (kg/yr)[a, c]	Final Total Nitrogen Load Allocation (kg/yr)[b, c]
TMDL	31,505	12,843	257,387	227,379
WLA	**4,739**	**1,704**	**18,072**	**10,268**
Supplemental water	3,721	1,488	7,442	7,442
Urban	635	135	6,692	1,779
CAFO	383	81	3,938	1,047
LA	**26,766**	**11,139**	**239,315**	**217,111**
Internal Sediment	21,554	9,948	197,370	197,370
Atmospheric Deposition	108	108	11,702	11,702
Agriculture	2,966	629	14,094	3,746
Open/Forest	1,733	368	5,630	1,497
Septic systems	405	86	10,519	2,796

[a] Interim allocation compliance to be achieved as soon as possible, but no later than December 31, 2009.
[b] Final allocation compliance to be achieved as soon as possible, but no later than December 31, 2019.
[c] TMDL and allocations specified as 5-year running average.

Table 5-9q

Canyon Lake
Nitrogen and Phosphorus Wasteload and Load Allocations

Canyon Lake Nutrient TMDL	Interim Total Phosphorus Load Allocation (kg/yr)[a, c]	Final Total Phosphorus Load Allocation (kg/yr)[b, c]	Interim Total Nitrogen Load Allocation (kg/yr)[a, c]	Final Total Nitrogen Load Allocation (kg/yr)[b, c]
TMDL	8,708	6,678	66,680	44,041
WLA	**660**	**313**	**13,807**	**7,784**
Supplemental water	0	0	248	248
Urban	419	199	8,391	4,664
CAFO	241	114	5,168	2,872
LA	**8,049**	**6,365**	**52,873**	**36,257**
Internal Sediment	4,625	4,625	13,549	13,549
Atmospheric Deposition	221	221	1,918	1,918
Agriculture	1,946	923	18,567	10,319
Open/Forest	1,025	486	6,477	3,600
Septic systems	232	110	12,362	6,871

[a] Interim allocation compliance to be achieved as soon as possible, but no later than December 31, 2009.
[b] Final allocation compliance to be achieved as soon as possible, but no later than December 31, 2019.
[c] TMDL and allocations specified as 5-year running average.

C. Margin of Safety

The Canyon Lake and Lake Elsinore Nutrient TMDLs include an implicit margin of safety (MOS) as follows:

- the derivation of numeric targets based on the 25th percentile of data for both lakes;
- the use of multiple numeric targets to measure attainment of beneficial uses and thereby ascertain TMDL efficacy;
- use of conservative literature values in the absence of site-specific data for source loading rates in the watershed nutrient model;
- use of conservative assumptions in modeling the response of Lake Elsinore and Canyon Lake to nutrient loads; and
- requiring load reductions to be accomplished during hydrological conditions when model results indicate, in some instances, that theoretical loads could be higher.

D. Seasonal Variations/Critical Conditions

The Canyon Lake and Lake Elsinore Nutrient TMDLs account for seasonal and annual variations in external and internal nutrient loading and associated impacts on beneficial uses, by the use of a 5-year running average allocation approach. This 5-year running average approach addresses variation in hydrologic conditions (wet, moderate and dry) that can dramatically affect both nutrient loading and lake response.

Compliance with numeric targets will ensure water quality improvements that prevent excessive algae blooms and fish kills, particularly during the critical summer period when these problems are most likely to occur.

E. TMDL Implementation

Table 5-9r outlines the tasks and schedules to implement the TMDL. Each of these tasks is described below.

Table 5-9r

Lake Elsinore and Canyon Lake Nutrient TMDL Implementation Plan/Schedule Report Due Dates

Task	Description	Compliance Date-As soon As Possible but No Later Than
TMDL Phase 1		
Task 1	Establish New Waste Discharge Requirements	*(*6 months after BPA approval*)*
Task 2	Revise Existing Waste Discharge Permits	*(*6 months after BPA approval*)*
Task 3	Watershed-wide Nutrient Water Quality Monitoring Program 3.1 Watershed-wide Nutrient Monitoring Plan(s) 3.2 Lake Elsinore Nutrient Monitoring Plan(s) 3.3 Canyon Lake Nutrient Monitoring Plan(s)	Plan/schedule due *(*3 months after BPA approval*)* Annual reports due August 15
Task 4	Agricultural Discharges – Nutrient Management Plan	Plan/schedule due *(*1 year after BPA approval*)*
Task 5	On-site Disposal Systems (Septic Systems) Management Plan	Plan/schedule due *(*6 months after BPA approval*)*
Task 6	Urban Discharges – Revision of Drainage Area Management Plan (DAMP) and Water Quality Management Plan (WQMP)	Plan/schedule due *(*6 months after BPA approval*)*
Task 7	Forest Area – Review/Revision of Forest Service Management Plans	Plan/schedule due *(*2 years after BPA approval*)*
Task 8	Lake Elsinore Lake In-Lake Sediment Nutrient Reduction Plan	Plan/schedule due *(*6 months after BPA approval)**
Task 9	Canyon Lake In-Lake Sediment Treatment Evaluation	Plan/schedule due *(*6 months after BPA approval*)*
Task 10	Watershed and Canyon Lake and Lake Elsinore In-Lake Model Updates	Plan/schedule due *(*6 months after BPA approval*)*
Task 11	Review and Revise Nutrient Water Quality Objectives	December 31, 2009
Task 12	Review of TMDL/WLA/LA	Once every 5 years

[Note: BPA => Basin Plan Amendment]

Task 1: Establish New Waste Discharge Requirements

On or before (**6 months from the effective date of this BPA*), the Regional Board shall issue new waste discharge requirements (NPDES permit) to Elsinore Valley Municipal Water District for supplemental water discharges to Canyon Lake that incorporate the appropriate interim and final wasteload allocations, compliance schedule and monitoring program requirements.

Other proposed nutrient discharges will be addressed and permitted as appropriate.

Task 2: Review and/or Revise Existing Waste Discharge Requirements

There are five Waste Discharge Requirements (WDRs) regulating discharge of various types of wastes in the San Jacinto watershed. On or before (**6 months from the effective date of this Basin Plan amendment**), each of these WDRs shall be reviewed and revised as necessary to implement the Lake Elsinore and Canyon Lake Nutrient TMDLs, including the appropriate nitrogen and phosphorus interim and final wasteload allocations, compliance schedules and monitoring program requirements.

2.1 Waste Discharge Requirements for the Riverside County Flood Control and Water Conservation District, the County of Riverside and the Incorporated Cities of Riverside County within the Santa Ana Region, Areawide Urban Runoff, NPDES No. CAS 618033 (Regional Board Order No. R8-2002-0011). The current Order has provisions to address TMDL issues (see Task 6.1, below). In light of these provisions, revision of the Order may not be necessary to address TMDL requirements.

2.2 Watershed-Wide Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with New Developments in the San Jacinto Watershed, Order No. 01-34, NPDES No. CAG 618005. It is expected that this Order will be rescinded once the Regional Board/Executive Officer approves a Water Quality Management WQMP) under Order No. R8-2002-0011 (see 2.1, above and Task 6.2, below)

2.3 General Waste Discharge Requirements for Concentrated Animal Feeding Operations (Dairies and Related Facilities) within the Santa Ana Region, NPDES No. CAG018001 (Regional Board Order No. 99-11).

2.4 Waste Discharge and Producer/User Reclamation Requirements for the Elsinore Valley Municipal Water District, Regional Water Reclamation Facility Riverside County, Order No. 00-1, NPDES No. CA8000027.

2.5 Waste Discharge Requirements for Eastern Municipal Water District, Regional Water Reclamation System, Riverside County, Order No. 99-5, NPDES No. CA8000188.

Task 3: Monitoring

3.1 Watershed-wide Nutrient Water Quality Monitoring Program

No later than (**3 months from effective date of this Basin Plan amendment **), the US Forest Service, the County of Riverside, the cities of Lake Elsinore, Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley, Murrieta and Beaumont, Eastern Municipal Water District, Elsinore Valley Municipal Water District, concentrated animal feeding operators and other agricultural operators within the San Jacinto watershed shall, as a group, submit to the Regional Board for approval a proposed watershed-wide nutrient monitoring program that will provide data necessary to review and update the Lake Elsinore and Canyon Lake Nutrient TMDL. Data to be collected and analyzed shall address, at a minimum: (1) determination of compliance with interim and/or final nitrogen and phosphorus allocations; and (2) determination of compliance with the nitrogen and phosphorus TMDL, including the WLAs and LAs.

At a minimum, the proposed plan shall include the collection of samples at the stations specified in Table 5-9s and shown in Figure 5-3, at the frequency specified in Table 5-9s. In addition to water quality samples, at a minimum, daily discharge (stream flow) determinations shall be made at all stations shown in Table 5-9s.

At a minimum, samples shall be analyzed for the following constituents:

- organic nitrogen
- ammonia nitrogen
- nitrite nitrogen
- nitrate nitrogen
- total phosphorus
- ortho-phosphate (SRP)
- total hardness
- total dissolved solids (TDS)
- total suspended solids (TSS)
- turbidity
- biological oxygen demand (BOD)
- chemical oxygen demand (COD)

The proposed monitoring plan shall be implemented upon Regional Board approval at a duly noticed public meeting. An annual report summarizing the data collected for the year and evaluating compliance with the WLAs/LAs shall be submitted by August 15 of each year.

In lieu of this coordinated monitoring plan, one or more of the parties identified above may submit a proposed individual or group monitoring plan for Regional Board approval. Any such individual or group monitoring plan is due no later than (*3 *months from effective date of this Basin Plan amendment**) and shall be implemented upon Regional Board approval at a duly noticed public meeting. An annual report of data collected pursuant to approved individual/group plan(s) shall be submitted by August 15 of each year. The report shall summarize the data and evaluate compliance with the WLAs/LAs.

Table 5-9s

Lake Elsinore and Canyon Lake Watershed
Minimum Required Sampling Station Locations

Station Number	Station Description
792	San Jacinto River @ Cranston Guard Station
318	Hemet Channel at Sanderson Ave.
745	Salt Creek @ Murrieta Road
759	San Jacinto River @ Goetz Rd
325	Perris Valley Storm Drain @ Nuevo Rd.
741	San Jacinto River @ Ramona Expressway
827	San Jacinto River upstream of Lake Elsinore
790	Fair Weather Dr. Storm Drain in Canyon Lake
357	4 Corners Storm Drain in Elsinore
714	Ortega Flood Channel in Elsinore
324	Lake Elsinore Outlet Channel
712	Leach Canyon Channel in Elsinore
834	Sierra Park Drain in Canyon Lake
835	Bridge Street and San Jacinto River
836	North Side of Ramona Expressway near Warren Road
837	Mystic Lake inflows
838	Mystic Lake outflows
841	Canyon Lake spillway

Frequency of sampling at all stations: dry season – none; wet season; minimum of 3 storms/year whenever possible and 8 samples across each storm hydrograph

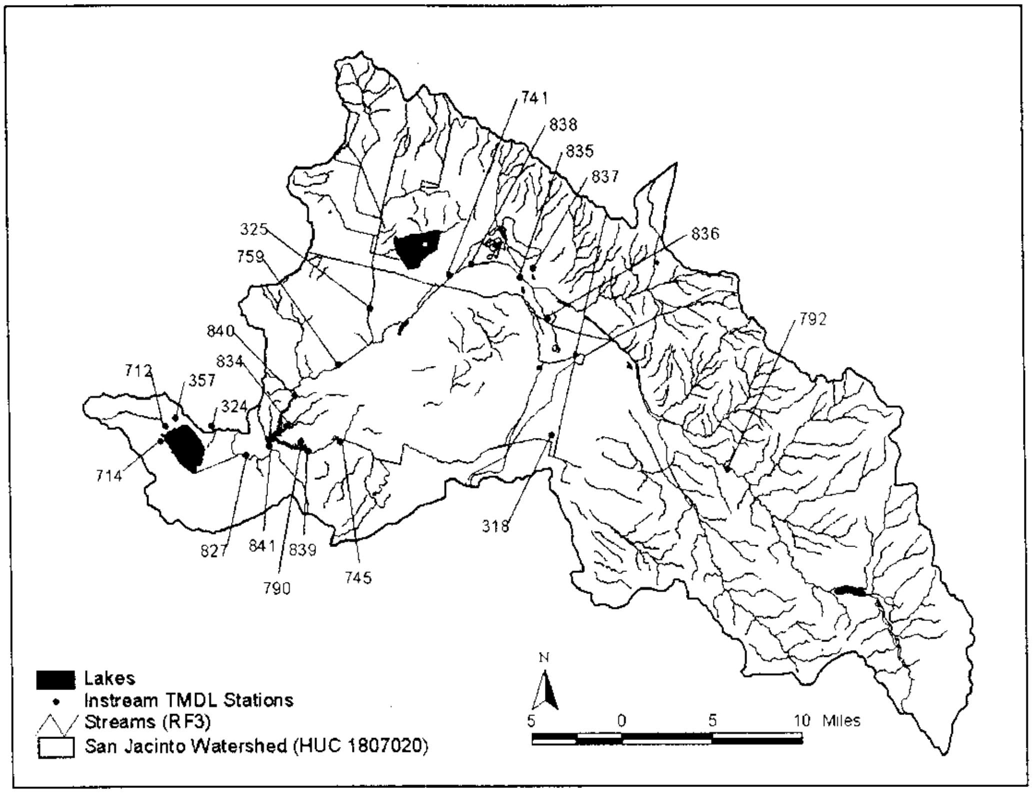

Figure 5-3 – San Jacinto River Watershed Nutrient TMDL Water Quality Stations Locations

3.2 Lake Elsinore: In-Lake Nutrient Monitoring Program

No later than (**3 months from effective date of this Basin Plan amendment* *), the US Forest Service, the County of Riverside, the cities of Lake Elsinore, Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley, Murrieta and Beaumont, Eastern Municipal Water District, Elsinore Valley Municipal Water District, concentrated animal feeding operators and other agricultural operators within the San Jacinto watershed shall, as a group, submit to the Regional Board for approval a proposed Lake Elsinore nutrient monitoring program that will provide data necessary to review and update the Lake Elsinore Nutrient TMDL. Data to be collected and analyzed shall address, at a minimum: determination of compliance with interim and final nitrogen, phosphorus, chlorophyll *a*, and dissolved oxygen numeric targets. In addition, the monitoring program shall evaluate and determine the relationship between ammonia toxicity and the total nitrogen allocation to ensure that the total nitrogen allocation will prevent ammonia toxicity in Lake Elsinore.

At a minimum, the proposed plan shall include the collection of samples at the stations specified in Table 5-9t and shown in Figure 5-4, at the specified frequency indicated in Table 5-9t. With the exception of dissolved oxygen and water temperature, all samples to be analyzed shall be depth integrated.

The monitoring plan shall be implemented upon Regional Board approval at a duly noticed public meeting. An annual report summarizing the data collected for the year and evaluating compliance with the TMDL shall be submitted by August 15 of each year.

Table 5-9t
Lake Elsinore Minimum Required Sampling Station Locations

Station Number	Station Description
LE 14	Lake Elsinore – inlet
LE 15	Lake Elsinore – four corners
LE 16	Lake Elsinore – mid-lake

Frequency of sampling at all stations: monthly October through May; bi-weekly June through September.

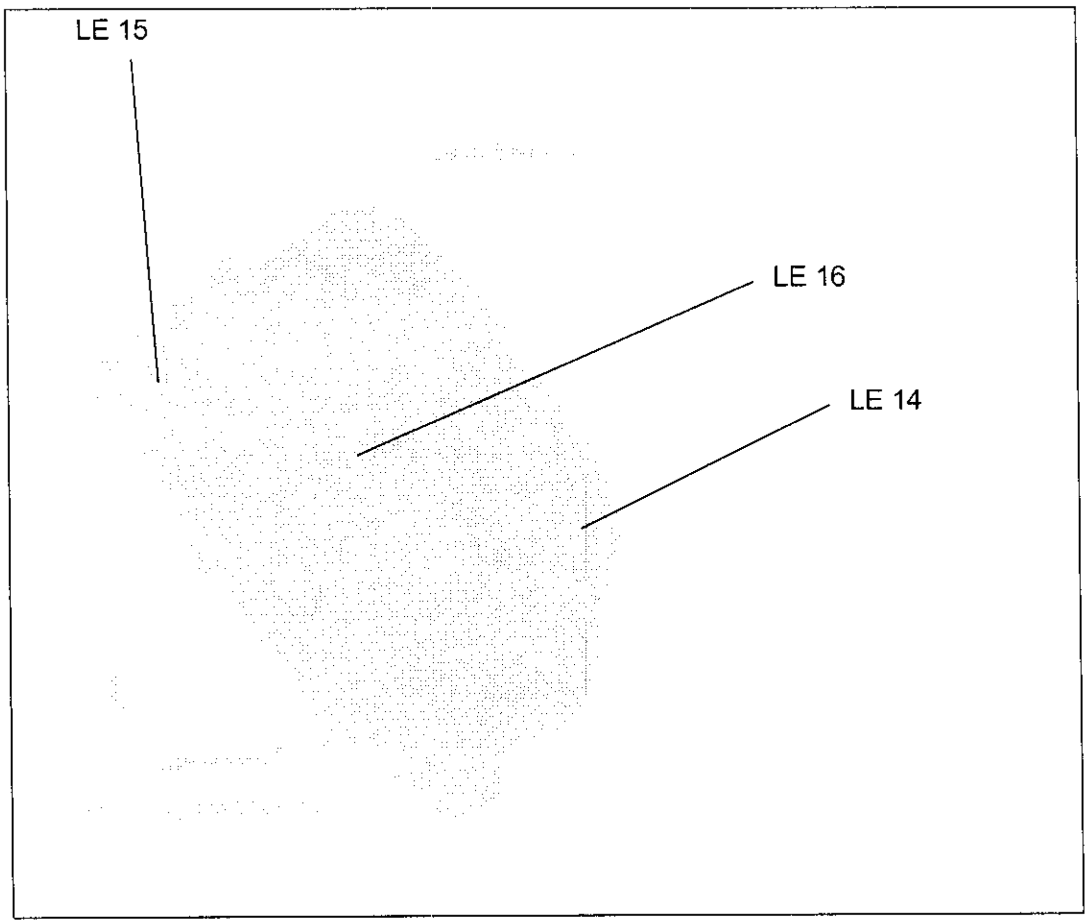

Figure 5-4 Lake Elsinore TMDL monitoring Stations

At a minimum, in-lake samples must be analyzed for the following constituents:

- specific conductance
- water temperature
- chlorophyll *a*
- organic nitrogen
- nitrite nitrogen
- organic phosphorus
- total hardness
- total dissolved solids (TDS)
- chemical oxygen demand (COD)
- dissolved oxygen
- water clarity (secchi depth)
- ammonia nitrogen
- nitrate nitrogen
- turbidity
- ortho-phosphate (SRP)
- total suspended solids (TSS)
- biological oxygen demand (BOD)

In lieu of this coordinated monitoring plan, one or more of the parties identified above may submit a proposed individual or group monitoring plan for Regional Board approval. Any such individual or group monitoring plan is due no later than (*3 *months from effective date of this Basin Plan amendment* *) and shall be implemented upon Regional Board approval at a duly noticed public meeting. An annual report of data collected pursuant to approved individual/group plan(s), shall be submitted by August 15 of each year. The report shall summarize the data and evaluate compliance with the numeric targets.

3.3 Canyon Lake Nutrient Monitoring Program

No later than (**3 months from effective date of this Basin Plan amendment* *), the US Forest Service, the County of Riverside, the cities of Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley, Murrieta and Beaumont, Elsinore Valley Municipal Water District, concentrated animal feeding operators and other agricultural operators within the San Jacinto watershed shall, as a group, submit to the Regional Board for approval a proposed Canyon Lake nutrient monitoring program that will provide data necessary to review and update the Canyon Lake Nutrient TMDL. Data to be collected and analyzed shall address, at a minimum: determination of compliance with interim and final nitrogen, phosphorus, chlorophyll *a*, and dissolved oxygen numeric targets. In addition, the monitoring program shall evaluate and determine the relationship between ammonia toxicity and the total nitrogen allocation to ensure that the total nitrogen allocation will prevent ammonia toxicity in Canyon Lake.

At a minimum, the proposed plan shall include the collection of samples at the stations specified in Table 5-9u and shown in Figure 5-5, at the specified frequency indicated in Table 5-9u. Discrete samples in Canyon Lake are to be collected in the epilimnion, hypolimnion and thermocline when and where appropriate.

The monitoring plan shall be implemented upon Regional Board approval at a duly noticed public meeting. An annual report summarizing the data collected for the year and evaluating compliance with the TMDL shall be submitted by August 15 of each year.

Table 5-9u

Canyon Lake Minimum Required Sampling Station Locations

Station Number	Station Description
CL 07	Canyon Lake – At the Dam
CL 08	Canyon Lake – North Channel
CL 09	Canyon Lake – Canyon Bay
CL 10	Canyon Lake – East Bay

Frequency of sampling at all stations: monthly October through May; bi-weekly June through September.

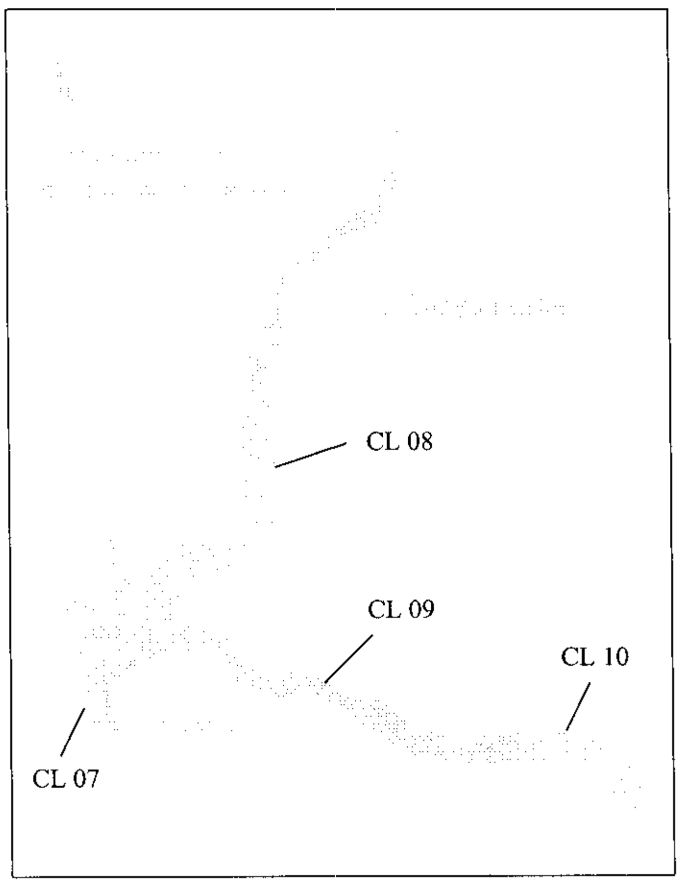

Figure 5-5 – Canyon Lake Nutrient TMDL Monitoring Station Locations

At a minimum, in-lake samples must be analyzed for the following constituents:

- specific conductance
- water temperature
- chlorophyll *a*
- organic nitrogen
- nitrite nitrogen
- organic phosphorus
- total hardness
- total dissolved solids (TDS)
- chemical oxygen demand (COD)
- dissolved oxygen
- water clarity (secchi depth)
- ammonia nitrogen
- nitrate nitrogen
- turbidity
- ortho phosphate
- total suspended solids (TSS)
- biological oxygen demand (BOD)

In lieu of this coordinated monitoring plan, one or more of the parties identified above may submit a proposed individual or group monitoring plan for Regional Board approval. Any such individual or group monitoring plan is due no later than (*3 *months from effective date of this Basin Plan amendment* *) and shall be implemented upon Regional Board approval at a duly noticed public meeting. An annual report of data collected pursuant to approved individual/group plan(s) shall be submitted by August 15 of each year. The report shall summarize the data and evaluate compliance with the numeric targets

Task 4: Agricultural Activities

No later than (**1 year from effective date of this Basin Plan amendment* *), the Riverside County Farm Bureau, the UC Cooperative Extension and agricultural operators within the Lake Elsinore and Canyon Lake watershed shall, as a group, submit a proposed Nutrient Management Plan (NMP). The Nutrient Management Plan shall be implemented upon Regional Board approval at a duly noticed public meeting.

In lieu of a coordinated plan, one or more of the parties identified above may submit a proposed individual or group Nutrient Management Plan to conduct the above studies for areas within their jurisdiction. Any such individual or group plan shall also be submitted for Regional Board approval no later than (**1 year from effective date of this Basin Plan amendment* *). This Nutrient Management Plan shall be implemented upon Regional Board approval at a duly noticed public meeting.

At a minimum, the NMP shall include, plans and schedules for the following:

- implementation of nutrient controls, BMPs and reduction strategies designed to meet load allocations;
- evaluation of effectiveness of BMPs;
- development and implementation of compliance monitoring; and
- development and implementation of focused studies that will provide the following data and information
  - ➢ inventory of crops grown in the watershed;
  - ➢ amount of manure and/or fertilizer applied to each crop with corresponding nitrogen and phosphorus amounts; and
  - ➢ amount of nutrients discharged from croplands.

The Regional Board expects that the NMP will be submitted and implemented on a voluntary basis. Where and when necessary to implement these requirements, the Regional Board will issue appropriate waste discharge requirements.

Task 5: On-site Disposal Systems (Septic System) Management Plan

No later than (**6 months from effective date of this Basin Plan amendment* *), the County of Riverside and the Cities of Perris, Moreno Valley and Murrieta shall, as a group, submit a Septic System Management Plan to identify and address nutrient discharges from septic systems within the San Jacinto watershed. The Septic System Management Plan shall implement regulations adopted by the State Water Resources Control Board pursuant to California Water Code Section 13290 – 13291.7.

At a minimum, the Septic System Management Plan shall include plans and schedules for the development and implementation of the following:

- public education program;
- tracking system, including maintenance thereof;
- maintenance standards;
- enforcement provisions;
- monitoring program; and
- sanitary survey.

In lieu of a coordinated plan, one or more of the agencies with septic system oversight responsibilities may submit an individual or group Management Plan to develop the above Plan for areas within their jurisdiction. Any such individual or group plan shall also be submitted no later than (**6 months from effective date of this Basin Plan amendment* *). This Septic System Management Plan shall be implemented upon Regional Board approval at a duly noticed public meeting.

Task 6: Urban Discharges – Revision of the Drainage Area Management Plan and Development of a new Water Quality Management Plan

6.1 DAMP Revisions: Provision XIII.B. of Order No. R8-2002-0011 (see 2.1, above) requires the permittees to revise their Drainage Area Management Plan (DAMP) to include TMDL requirements. Each year, by August 1, the permittees are required to review and revise their DAMP as necessary. These revisions shall include schedules for meeting the interim and final nutrient wasteload allocations. The co-permittees shall also provide a proposal for 1) evaluating the effectiveness of BMPs and other control actions implemented and 2) evaluating compliance with the nutrient waste load allocation for urban runoff. The proposal must be implemented upon Regional Board approval at a duly noticed public meeting. The DAMP revisions along with the approved WQMP (see 6.2, below), shall address the urban component of the nutrient TMDL.

6.2 WQMP: Provision VIII.B. of Order No. R8-2002-0011 (see 2.1, above) requires the permittees to develop and submit a WQMP by June 2004 for the Executive Officer's approval. The WQMP shall address the urban component of nutrient TMDL from new developments and significant redevelopments. The WQMP shall also include requirements currently in Order No. 01-34 (see 2.2, above). Once the WQMP is approved, Order No. 01-34 will be rescinded.

Task 7: Forest Area – Revision of Forest Service Management Plans

No later than (**2 years from effective date of this Basin Plan amendment* *), the US Forest Service shall submit for approval a plan and schedule for review and revision of the Cleveland National Forest Service Management Plan and the San Bernardino National Forest Service Management Plan to identify watershed-specific appropriate Best Management Practices (BMPs) that will be implemented to achieve the interim and final load allocations for forest/open space. The proposal shall include specific recommendations for 1) evaluating the effectiveness of control actions implemented to reduce nutrient discharges from forest/open space and 2) evaluating compliance with the nutrient load allocation from forest/open space. The revised watershed-specific BMPs shall be implemented upon Regional Board approval at a duly noticed public meeting.

Task 8: Lake Elsinore Sediment Nutrient Reduction Plan

No later than (**6 months from effective date of this Basin Plan amendment **), the US Forest Service, the County of Riverside, the cities of Lake Elsinore, Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley, Murrieta and Beaumont, Eastern Municipal Water District, Elsinore Valley Municipal Water District, concentrated animal feeding operators and other agricultural operators within the San Jacinto watershed shall, as a group, submit to the Regional Board for approval a proposed plan and schedule for in-lake sediment nutrient reduction for Lake Elsinore. The proposed plan shall include an evaluation of the applicability of various in-lake treatment technologies to prevent the release of nutrients from lake sediments to support development of a long-term strategy for control of nutrients from the sediment. The submittal shall also contain a proposed sediment nutrient monitoring program to evaluate the effectiveness of any strategies implemented. The Lake Elsinore In-lake Sediment Nutrient Reduction Plan shall be implemented upon Regional Board approval at a duly noticed public meeting.

In lieu of this coordinated monitoring plan, one or more of the parties identified above may submit a proposed individual or group In-lake Sediment Nutrient Reduction Plan for approval by the Regional Board. Any such individual or group Plan is due no later than (*6 *months from effective date of this Basin Plan amendment**) and shall be implemented upon Regional Board approval at a duly noticed public meeting.

Task 9: Canyon Lake Sediment Nutrient Treatment Evaluation Plan

No later than (**6 months from effective date of this Basin Plan amendment **), the US Forest Service, the County of Riverside, the cities of Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley. Murrieta and Beaumont, Elsinore Valley Municipal Water District, concentrated animal feeding operators and other agricultural operators within the San Jacinto watershed shall, as a group, submit to the Regional Board for approval a proposed plan and schedule for evaluating in-lake sediment nutrient treatment strategies for Canyon Lake. The proposed plan shall include an evaluation of the applicability of various in-lake treatment technologies to prevent the release of nutrients from lake sediments in order to develop a long-term strategy for control of nutrients from the sediment. The submittal shall also contain a proposed sediment nutrient monitoring program to evaluate the effectiveness of any strategies implemented. The Canyon Lake In-lake Sediment Nutrient Treatment Plan shall be implemented upon Regional Board approval at a duly noticed public meeting.

In lieu of this coordinated monitoring plan, one or more of the parties identified above may submit a proposed individual or group In-lake Sediment Nutrient Treatment Evaluation Plan for approval by the Regional Board. Any such individual or group Plan is due no later than (*6 *months from effective date of this Basin Plan amendment**) and shall be implemented upon Regional Board approval at a duly noticed public meeting.

Task 10: Update of Watershed and In-Lake Nutrient Models

No later than (**6 months from effective date of this Basin Plan amendment **), the US Forest Service, the County of Riverside, the cities of Lake Elsinore, Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley and Beaumont, Eastern Municipal Water District, Elsinore Valley Municipal Water District, concentrated animal feeding operators and other agricultural operators shall, as a group, submit to the

Regional Board for approval a proposed plan and schedule for updating the existing Lake Elsinore/San Jacinto River Nutrient Watershed Model and the Canyon Lake and Lake Elsinore in-lake models. The plan and schedule must take into consideration additional data and information that are generated from the respective TMDL monitoring programs.

The plan for updating the Watershed and In-lake Models shall be implemented upon Regional Board approval at a duly noticed public meeting.

Task 11: Review and Revision of Water Quality Objectives

By December 31, 2009, the Regional Board shall review and revise as necessary the total inorganic nitrogen numeric water quality objectives for Lake Elsinore and Canyon Lake. In addition, the Regional Board shall evaluate the appropriateness of establishing total phosphorus numeric water quality objectives for both Lake Elsinore and Canyon Lake. Given budgetary constraints, completion of this task is likely to require substantive contributions from interested parties.

Task 12: Review/Revision of the Lake Elsinore/Canyon Lake Nutrient TMDL

The basis for the TMDLs and implementation schedule will be re-evaluated at least once every five years[1] to determine the need for modifying the load allocations, numeric targets and TMDLs. Regional Board staff will continue to review all data and information generated pursuant to the TMDL requirements on an ongoing basis. Based on results generated through the monitoring programs, special studies and/or modeling analysis, changes to the TMDL may be warranted. Such changes would be considered through the Basin Plan Amendment process.

The Regional Board is committed to the review of this TMDL every five years, or more frequently if warranted by these or other studies

[1] The five-year schedule is tied to the 5-year running average allocation approach employed in the Lake Elsinore/Canyon Lake nutrient TMDLs.

References

1. California Regional Water Quality Control Board, Lake Elsinore Nutrient TMDL Problem Statement, October, 2000.

2. California Regional Water Quality Control Board, Canyon Lake Nutrient TMDL Problem Statement, October 2001.

3. California Regional Water Quality Control Board, Total Maximum Daily Load for Nutrients in Lake Elsinore And Canyon Lake, March, 2004

ATTACHMENT B

ENVIRONMENTAL CHECKLIST

I. BACKGROUND

1. **Project title:** *Basin Plan amendment to incorporate Nutrient TMDLs for Canyon Lake and Lake Elsinore in the San Jacinto River Watershed*

2. **Lead agency name and address:** *California Regional Water Quality Control Board, Santa Ana Region, 3737 Main Street, Suite 500, Riverside, CA 92501-3348*

3. **Contact person and phone number:** *Hope Smythe (909) 782- 4493*

4. **Project location:** *San Jacinto River Watershed, Riverside County (all or portions of Idyllwild, Hemet, San Jacinto, Perris, Moreno Valley, Canyon Lake, Lake Elsinore, Beaumont, and Murrieta)*

5. **Project sponsor's name and address:** *California Regional Water Quality Control Board, Santa Ana Region, 3737 Main Street, Suite 500, Riverside, CA 92501-3348*

6. **General plan designation:** *Not applicable*

7. **Zoning:** *Not applicable*

8. **Description of project:** *Adoption of a Basin Plan amendment to incorporate Nutrient TMDLs for Canyon Lake and Lake Elsinore. The TMDLs establish wasteload allocations and load allocations for allowable nutrient inputs by all identified sources that discharge to Canyon Lake and Lake Elsinore. The intent is to achieve numeric, water quality targets that will protect the beneficial uses of the lakes. The Basin Plan amendment includes an implementation that details the actions required by the Regional Board and other responsible parties to implement the TMDL.*

9. **Surrounding land uses and setting:** *Not applicable*

10. **Other public agencies whose approval is required:** *The Basin Plan amendment must be approved by the State Water Resources Control Board, the Office of Administrative Law, and the U.S. Environmental Protection Agency before it becomes effective.*

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:
The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agricultural Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology / Water Quality	☐ Land Use / Planning
☐ Mineral Resources	☐ Noise	☐ Population / Housing
☐ Public Services	☐ Recreation	☐ Transportation / Traffic
☐ Utilities / Service Systems	☐ Mandatory Findings of Significance	

II. DETERMINATION

On the basis of this initial evaluation:

X I find that the proposed project COULD NOT have a significant effect on the environment.

____ I find that the proposed project MAY have a significant effect on the environment. However, there are feasible alternatives and/or mitigation measures available that will substantially lessen any adverse impact. These alternatives are discussed in the attached written report.

____ I find that the proposed project MAY have a significant effect on the environment. There are no feasible alternatives and/or feasible mitigation measures available that would substantially lessen any significant adverse impact. See the attached written report for a discussion of this determination.

Hope Smythe
Signature

3/26/04
Date

Hope Smythe
Senior Environmental Specialist

III. ENVIRONMENTAL IMPACTS

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS - Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?				X
d) Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X
III. AIR QUALITY - Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient				X

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?				
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES - Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?				X
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations, or by the California Department of Fish and Game or US Fish and Wildlife Service?				X
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?			X	
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?			X	
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X
V. CULTURAL RESOURCES - Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in ¤15064.5?				X
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to ¤15064.5?				X
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
d) Disturb any human remains, including those interred outside of formal cemeteries?				
VI. GEOLOGY AND SOILS - Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-site or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				X
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?				X
VII. HAZARDS AND HAZARDOUS MATERIALS - Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				X
VIII. HYDROLOGY AND WATER QUALITY - Would the project:				
a) Violate any water quality standards or waste discharge requirements?				X
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on-site or off-site?				X
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on-site or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?				X
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
h) Place within a 100-year flood hazard area structures that would impede or redirect flood flows?				X
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X
IX. LAND USE AND PLANNING - Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES - Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE - Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?				X
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people				X

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
residing or working in the project area to excessive noise levels?				
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING - Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services: Fire protection? Police protection? Schools? Parks? Other public facilities?				X
XIV. RECREATION - Would the project:				
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC - Would the project:				
a) Cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				X
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS - Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?			X	
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?			X	
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider that serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE -				

CEQA Checklist

Question	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?				X
b) Does the project have impacts that are individually limited, but cumulatively considerable? ('Cumulatively considerable' means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?				X
c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?				X

Attachment - Environmental Checklist

Discussion of Environmental Impacts

Explanation of Environmental Checklist "Less than significant" Answers

Note: Adoption of the Basin Plan amendment to incorporate Nutrient TMDLs for Canyon Lake and Lake Elsinore will not have any direct impact on the environment. Implementation of actions necessary to achieve the TMDLs may affect the environment, as described below. However, the intent of TMDL implementation is to restore and protect the water quality of the lakes and their beneficial uses. Any potential adverse environmental effects associated with TMDL implementation will be subject to project-specific CEQA analysis and certification to assure appropriate avoidance/minimization and mitigation.

IV. Biological Resources (c), (d)

The proposed TMDLs call for actions to reduce internal nutrient loading to the lakes, which may include fishery management and sediment removal. Such actions would clearly affect, or have the potential to affect, the biota. Any such actions would be subject to specific CEQA analysis and certification, and would be intended to restore and protect the biological resources of the lake.

XI. Noise (d)

Implementation of actions necessary to implement the proposed TMDLs may result in increases in noise levels. However, these effects are expected to be limited in scope and duration and are not considered significant. Again, proposed implementation actions would be subject to specific CEQA analysis and certification.

XVI. Utilities and Service Systems (b), (c)

The proposed TMDLs call for reductions in nutrient contributions to the lakes from septic systems and storm drainage systems. To achieve these reductions, modifications to the storm drainage system may be necessary. Similarly, it may be that septic system modifications, or connection of existing septic systems to sewer systems, will be necessary. Connection of existing septic systems to sewer systems may require collection and/or wastewater treatment plant modifications/expansions, with attendant construction-related environmental effects. In addition, wastewater treatment plant modifications may be needed to meet the nutrient wasteload allocations. Any such projects associated with septic, sewer or storm drainage systems modifications would be subject to further, case-specific environmental review and certification.